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DECEMBER, 1953

New 10-Color Map of the Great Lakes Region

Aviation Looks Ahead on Its 50th Birthday
VICE ADMIRAL EMORY S. LAND
With 14 Illustrations, 9 in Natural Colors 721

Fifty Years of Flight
31 Historic Photographs 740

Fact Finding for Tomorrow's Planes
DR. HUGH L. DRYDEN 757
With 33 Illustrations, 31 in Color LUIS MARDEN

Illinois—Healthy Heart of the Nation 781
With 36 Illustrations LEO A. BORAH
28 in Natural Colors B. A. STEWART, W. R. CULVER

Presenting the Historic Great Lakes Region 821

Ontario, Pivot of Canada's Power 822
ANDREW H. BROWN
With 29 Illustrations B. ANTHONY STEWART
20 in Natural Colors and BATES LITTLEHALES

Jericho Gives Up Its Secrets 853
With 20 Illustrations KATHLEEN M. KENYON
12 in Natural Colors A. DOUGLAS TUSHINGHAM

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Aviation Looks Ahead on Its 50th Birthday

Now a Billion-dollar Business, Airlines Plan Jet Transports, Fast Freighters, and Downtown Helicopter Ports

By Vice Admiral Emory S. Land, USN (Ret.)

President, Air Transport Association of America, and
Life Trustee of the National Geographic Society

On the morning of December 17, 1903, an obscure bicycle mechanic clambered aboard a strange-looking craft, nodded to his brother and a small group of onlookers, and began one of history's greatest voyages of discovery.

His journey lasted just 12 seconds.

In those few fleeting moments a frail, kite-like machine bore Orville Wright aloft and carried him safely a distance of 120 feet across the desolate, wind-whipped sands at Kitty Hawk, North Carolina (page 740).

Humanity's age-old dream had been realized. Man had flown successfully for the first time in a powered, heavier-than-air machine.

Celebrating a Year of Jubilee

In the United States, and in many foreign lands on freedom's side of the Iron Curtain, that epoch-making achievement will be commemorated with special ceremonies on December 17, 1953, the fiftieth anniversary of powered flight.

Here in our own land all of 1953 has been declared a Golden Jubilee celebration of the airplane's birth. There have been scores of commemorative events, among them air meets, State and regional air tours by the Civil Air Patrol, special radio and television programs, airport dedications, special newspaper editions, and the issuance of an anniversary airmail stamp.

Perhaps you, like myself, belong to that older generation whose lifetime spans the entire history of successful flight. If so, I am sure you feel, as I do, a sense of wonder at the tremendous scope of the achievements we have witnessed in aviation.

Fifty years is a mere moment in time compared to the millenniums that have passed since man's invention of the wheel. Yet in that relatively brief interval we have seen the airplane grow from a fragile thing of wood, cloth, and wire into the fastest means of travel ever devised.

We, and our children, have seen the warplane play a major role in shaping the fate of nations. We have seen the airliners of peaceful commerce change the habits and living standards of ourselves and our neighbors.

With no exaggeration, mankind's first half century of powered flight has been called "the fifty years that changed the world."

The Wright brothers made a total of four flights that memorable winter's morning, averaging an air speed of 31 miles per hour. The longest flight, with co-inventor Wilbur at the controls, went 852 feet in 59 seconds.

Speeds and Loads Vastly Increased

How unimpressive these figures inevitably seem in an age when fleets of huge airliners wing along our busy skyroads! I doubt if even the Wright brothers could have dreamed in 1903 how greatly their distances and speeds would be exceeded.

Including fuel and Orville, the Wright aircraft weighed 750 pounds. Today any one of a number of planes in the United States scheduled air fleet can carry 50 times that weight and fly 12 to 15 hours nonstop.

Recently a United States research plane

MILITARY AIR TRANSPORT SERVICE

streaked more than four miles in the 12 seconds Orville required to travel 40 yards.

Even the fuselages of some modern military aircraft are longer than that first flight!

In our Air Age the farthest spot on earth is only hours away. Leaving New York, an airlines passenger can reach Paris in 13 hours, Chicago in 3¾, Los Angeles in 10¾, Rome in 19½, Tokyo in 39.

By the time this article appears, one airline plans to be operating the first nonstop coast-to-coast service. New DC-7's will make the flights in less than eight hours.

Air Travel Sets Records

The Wright brothers, though gifted dreamers, could not have visualized in those struggling pioneer days the hordes of people who would one day travel by air.

In 1952 United States domestic and international scheduled airlines—i.e., those certificated for route operations by the Civil Aeronautics Board—carried a record 27,386,504 passengers, the equivalent of nearly one-sixth of the Nation's population. In 1953 we shall undoubtedly better that total; figures for the first six months show a 20 percent increase over the corresponding period of 1952.

To handle the growing tide of traffic, our scheduled airlines are constantly modernizing and adding to a fleet of some 1,400 planes. Our airlines fly 236,000 route miles and offer more lift capacity than the rest of the world's air carriers combined.

While achieving that growth, the airlines constantly improved their records for safety.

On February 11, 1953, the domestic scheduled carriers completed 12 months of operations without a single fatality. During that period they averaged a landing or take-off every seven seconds, or approximately 13,000 per day.

Wilbur Wright died of typhoid fever in 1912. Orville, the younger brother, lived until 1948 and saw aircraft put to a multiplicity of uses which would have strained the imagination of a Jules Verne: rain making, crop dusting and spraying, power-line patrol, mineral prospecting, game surveys, forest-fire fighting—even the herding of livestock (page 737).

Today, exclusive of the military and the airlines, there are approximately 88,000 airplanes in service in the United States, most of them operated by private flyers.

A half century ago there were only two power-plane pilots in the entire world. In 1952 there were 267,759 active civilian pilots in the United States alone.

More than 16,000 of these flyers are members of the Civil Air Patrol, civilian auxiliary of the United States Air Force. Organized into 52 wings, one to each State and Territory, CAP flies air search and rescue missions, airlifts supplies in time of disaster, supports the Nation's aerial defense observation system, and currently instructs more than 48,000 cadet members in aviation subjects.

Airlines Plan a New Era

Of aviation's many facets, the one affecting our lives most directly, and perhaps of greatest interest, is public transportation.*

As president of the Air Transport Association of America, a nonprofit service organization representing 42 scheduled airlines, I am intimately concerned each day with the sharp growing pains of a still-youthful industry. In 1952, for the first time, the airlines entered the billion-dollar industry class in annual gross revenue. We have grown big, but we are destined to grow much, much bigger.

That growth will see many changes. What will they hold in greater speed, comfort, and convenience for airlines customers?

I'll answer that question, but first let me disclaim the role of prophet. Few industries are so dynamic and changeable as the air transport business. (I once told my board of directors they were "a grand bunch of prima donnas.") Competition is keen, the problems large, the imponderables many. No one can foresee all the changes that lie ahead, and none can claim special clairvoyance.

Nevertheless, a number of developments can be predicted with reasonable certainty *if the world remains at peace.* In most instances my thinking on these future developments typifies the viewpoint of many colleagues.

Our Nation is about to enter a new era in commercial air travel—the age of the gas turbine aircraft, already introduced elsewhere in the world by the enterprising British with their jet-powered Comet airliners.

* See "Our Air Age Speeds Ahead," by F. Barrows Colton, NATIONAL GEOGRAPHIC MAGAZINE, February, 1948.

◄ Military and Civil Air Transport Chiefs Confer on U. S. Defense

Commercial airlines form an integral part of the Nation's defense system. Mobilization plans earmark nearly 300 four-engined planes for transfer to the Military Air Transport Service on 48 hours' notice. Of this number, more than 85 percent will be leased from scheduled airlines, the remainder from nonscheduled carriers.

Here the author, Emory S. Land, president of the Air Transport Association of America, represents the scheduled airlines at a meeting with Lt. Gen. Joseph Smith, commander of MATS, at Andrews Air Force Base, Maryland. The polar map shows MATS' globe-girdling routes; the swept-wing model aircraft represents a proposed jet transport.

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Kodachrome by Volkmar Wentzel and Bates Littlehales

↑ 23 Firms Helped Build This Copy of the First Wright Plane

In honor of the airplane's 50th birthday, Los Angeles members of the Institute of the Aeronautical Sciences decided to duplicate the original Kitty Hawk *Flyer*. They assigned the making of components to volunteer companies and gave Northrop Aeronautical Institute, Hawthorne, California, the job of wing-panel construction and final assembly. All work and materials were donated.

The finished reproduction, shown at Hawthorne, is a twin of the original in every detail but one: its engine is a wood and metal mockup (p. 728). After dedicatory ceremonies last July 15, IAS members put the plane on display in their W. F. Durand Aeronautical Museum, Los Angeles.

England's Kensington Science Museum has the only other full-scale copy. The museum contributed blueprints to the IAS project, as did the National Air Museum of the Smithsonian Institution, Washington, D. C., custodian of the original Wright plane.

George M. Russel, grandnephew of the Wright brothers and an aeronautical engineer, lies prone on the wing, demonstrating the pilot's position to jet ace Robert J. Love, now a test pilot for Northrop Aircraft, Inc.

Upper left: Stunt pilot Joseph Boone, entertaining at an air show in Richmond, Virginia, last May 16, flies a 1910 Curtiss pusher. Its "butter paddle" propeller, powered by a 1918 Curtiss motor, drives the venerable relic a scorching 45 miles an hour. Paul Mantz, owner of this and other old planes, contracts for their use in air shows and movies.

← All 88 Seats Were Taken on This Flight

In 1948 airlines introduced an attractive bargain on domestic runs: air coach or tourist service at approximately 30 percent less than first-class fares. In 1952 carriers inaugurated the service on transatlantic runs, making possible vacations abroad for thousands of Americans who lacked time to go by ship. Today about 23 percent of all air travel in the United States is by coach.

Seating arrangements are less spacious on coach flights and luxury services are curtailed, but planes are the same types used for first-class travel.

These coach passengers prepare for take-off from Washington on a TWA run to the Pacific coast.

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Kodachromes by Lois Marden, John E. Fletcher, Donald McBain, and Guy Martin, National Geographic Staff

Basically, there are two types of gas turbine power plants: the propellerless turbojet, usually referred to simply as the jet, or pure jet, obtaining thrust from a blast of hot gas; and the lesser-known turboprop, which gears its whirling turbine to a propeller (page 770).

Today practically all developmental work on large piston aircraft engines has been abandoned in the United States in favor of these two new types. Our latest airliners, the DC-7 and the Super Constellation, probably will be the last big new-model transports with reciprocating engines (pages 730, 732).

Jet Debut Expected Soon

I believe 1956 will see a jet transport introduced in domestic operation and another placed in service by a United States transatlantic carrier. Our first jet may be an improved type of the British Comet, or a new Boeing 707 transport, now in prototype construction phase. Other possibilities are on the drawing boards.

Many of our present airliners could be converted to turboprop power, and we may see such aircraft in service by 1956, or perhaps even sooner. New planes specifically designed for turboprop operation are contemplated, but American manufacturers have indicated they will introduce their speedy jet transports first.

In 10 to 15 years jetliners of American manufacture may replace most piston-driven aircraft on transcontinental and a number of other long-haul routes.

You may be an inveterate air traveler, but I predict your first flight in one of these jets will be the smoothest, most pleasant journey you have ever undertaken.

Your plane will be luxuriously fitted, with seats for about 80 passengers, plus a lounge. You will fly at 35,000 to 40,000 feet, far above the weather. Outside, the air will be rarefied and below zero, but inside the cabin, with its double windows for safer pressurization, you will still be warm and comfortable.

Since the jet has no propellers, your plane will be virtually without vibration; therefore, fatigue will be reduced. The roar of the engines will be muted to a murmur by sound insulation in the fuselage. You will cruise at about 550 miles an hour, compared to 365 for our fastest piston liner.

Despite one stop en route, our first jet transports will cross the continent in less than seven hours, clipping an hour from the nonstop DC-7 schedules (page 723).

But in 25 years, perhaps sooner, an airlines passenger will leave New York at noon and arrive in Los Angeles at noon! The time zone differential will erase the three hours required by his supersonic jet to streak across the country.

The jet's optimum performances will be on long flights at high altitudes. The turboprop, more economical to operate, promises to be most effective on intermediate runs and on extreme long-haul routes.

The turboprop has a glittering future, both as a transport plane and as a cargo carrier. Although not so fast as the jet, it will cruise at 450 miles an hour. When fully engineered, it will reduce cargo costs per ton mile, enabling the airlines to capture an increased share of the freight and express now being carried by surface transportation.

Last year domestic and foreign airlines carried more people to and from the United States than did ships. Domestically, our airlines accounted for nearly 57 percent of the first-class travel market, as compared to about one percent in 1932. Jets and turboprops will increase the trend to air travel.

I am confident that in 10 years' time the scheduled airlines will carry 60,000,000 passengers a year compared to our present 27,000,000. Instead of 2,000,000 miles per day, our planes will log 5,000,000, equal to 10 round trips to the moon every 24 hours!

Airlines are planning the large-scale introduction of helicopters, an innovation that seems likely to arouse more general interest than perhaps any other "new look" in aviation (page 738).

I predict that in 10 to 15 years big multi-engined 50-passenger helicopters will replace fixed-wing aircraft on many routes of less than 300 miles through large population areas. They will be economical, safe, and reasonably fast. Their ability to hover and descend vertically will enable passengers to disembark at downtown heliports instead of outlying airports, saving valuable time—and saving time is commercial aviation's prime asset.

Automatic Flight a Possibility

Today new electronic aids permit airlines to maintain dependable all-weather schedules. So promising is the outlook in electronics that completely automatic flight is a distinct probability during aviation's second half century.

Amazingly versatile electronic brains will take airliners off, fly them to their destinations, and land them safely and smoothly. Pilots will ride in the cockpits, but only to monitor the automatic equipment.

This technique is, of course, not a reality today, and it may be 25 years before we see it in use by the airlines.

I intend to discuss each of these future developments—jet, turboprop, helicopter, and automatic flight—in more detail, answering a number of questions that must be in the reader's mind.

But first, for a better understanding of the

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Kodachrome by National Geographic Photographer David S. Boyer

Tower Operators Direct Washington, D. C., Air Traffic from a Radio Console

On a busy day the National Airport records more than 700 landings and take-offs. Farthest man and girl beside him control airborne traffic. Others direct ground movements and transmit flight data.

Boeing Airplane Company

Pilot and Crew Work in Office-size Quarters Aboard a Boeing Stratocruiser

Extra roominess and comfort make the Stratocruiser a favorite with crew and passengers. This nose compartment of the 72-ton airliner houses pilot and copilot, flight engineer (center), and navigator (left).

airlines and their problems, let's take a look at the half century now ending. Let's see how the airlines grew.

A beloved war hero, Lt. Gen. James H. Doolittle, heads the National Committee to Observe the 50th Anniversary of Powered Flight. While working with Jimmy's executive committee, I have been amazed to find how little the general public knows about the birth of the airplane.

As a case in point, here is a favorite yarn of mine:

Those "Lucky" Wright Brothers

Early in 1953 several organizations decided to build full-size reproductions of the original Wright plane. One is a museum piece (page 725).

Two other groups planned powered copies which would actually be flown by test pilots. Later these projects were abandoned.

A private pilot of my acquaintance asked an industrial executive who headed one of the projects why his program had suddenly been grounded.

"Well, we just didn't think the confounded plane would fly."

"Not really!" my friend exclaimed. "Who was going to build it?"

"Oh, we had 10 aeronautical engineers lined up for the job."

"And they couldn't make it fly? Why, two bicycle mechanics were able to do it!"

"Yes," growled the executive, "but they had a lot of horseshoes with them!"

His reply typifies a myth that is all too prevalent—the myth of the Wright brothers' "lucky" achievement.

Actually, luck played a very small role in their work. The brothers, faltering though their first flights were, unlocked the secrets of the air. An excellent account of their early experiments and struggle for recognition accompanies the historic photographs beginning on page 740.

One of the few sage, respected voices to

declare faith in the possibility of flight prior to Kitty Hawk was that of Dr. Alexander Graham Bell, inventor of the telephone and president of your Society from 1898 to 1903.

In the June, 1903, NATIONAL GEOGRAPHIC MAGAZINE, featuring an account of his experimental kites, Dr. Bell wrote:

"We are all of us interested in aerial locomotion; and I am sure that no one who has observed with attention the flight of birds can doubt for one moment the possibility of aerial flight by bodies specifically heavier than the air. In the words of an old writer, 'We cannot consider as impossible that which has already been accomplished.'"

Later, during aviation's pioneer years, the distinguished scientist predicted that aircraft would attain high speeds and forecast 13-hour transatlantic crossings by air.

In the airplane's infancy most people believed it lacked commercial possibilities. A statement by Octave Chanute, friend of the Wrights and a prominent engineer and glider pioneer, typifies the thinking of the day.

Writing in the Smithsonian Institution's annual report for 1903, Chanute forecast a limited military use for the airplane and said it might even carry mail "in special cases." Then he declared:

"But the useful loads carried will be very small. The machines will eventually be fast, they will be used in sport, but they are not to be thought of as commercial carriers. To say nothing of the danger, the sizes must remain small and the passengers few."

However, by 1914 flying boats were shuttling passengers back and forth between Tampa and St. Petersburg, Florida. This service has been called the first scheduled air passenger line in the United States. It was an unprofitable, short-lived venture, as were several similar undertakings that followed, but they served as yardsticks for future operations.

World War I Boosted Aviation

World War I gave tremendous impetus to the development of the airplane. Having participated mightily in that development, our Government naturally desired to capitalize on it in time of peace.

Speedier delivery of mail proved to be the airplane's first peacetime use.

In May, 1918, the War Department inaugurated regular air mail between New York and Washington, D. C. Later that year the Post Office Department took over the service.

New York-to-Chicago air mail was established by 1919; San Francisco was added to the route the next year. Night air mail, Chicago to the west coast, started in 1924 and was extended to New York in 1925.

This was the brief, brave era of the pilot veterans of World War I and the happy-go-lucky barnstormers of the postwar aerial circus days. They were the men hired to fly the pioneering planes, the men who put new meaning into the Post Office slogan, "The mail must go through."

So rudimentary were navigational aids that the odds were 25 to 1 against an air-mail pilot's survival over an 18-month period. In those days, when flying blind, men often had to judge their angle of flight by "the feel of the seat of the pants." Mechanical failure was relatively commonplace.

I was doing some flying in the 1920's, first as a Navy aerial observer, and later as a pilot. Any forced landing you could walk away from was a good one, and I was lucky enough to walk away from five!

There was no Civil Aeronautics Administration then to impose safety regulations and strict discipline. Pilots were a venturesome fraternity. They pulled some stunts that probably would cost them their licenses today.

In one such episode I was the butt of an amusing but hair-raising practical joke.

Plane "Buzzes" Speeding Train

My friend Al Williams, later renowned as a speed king, was flying me across the Maryland countryside in a two-seated open-cockpit de Haviland biplane. Suddenly the irrepressible Williams swooped down upon a speeding passenger train.

Overtaking the engine, he jockeyed the plane into a position above the smokestack and reduced our speed until it matched that of the train. So nicely did he judge the maneuver that only the rear cockpit, in which I sat, caught the smoke from the stack.

Engulfed in cinders and noxious fumes, I coughed, spluttered, and choked. Beating on the rim of the cockpit, I voiced my opinion of Williams in profane shouts. Finally Al tired of the game and hedgehopped away across the fields. When we landed I looked like the end man in a minstrel show.

Today such questionable lurks have all but vanished from the aviation scene.

In 1926 the Federal Government turned over flying the mail to private contractors. Under private enterprise the nucleus of the airlines we know today took form.

The big challenge was to deliver the mail in the shortest time. The letter that today takes 10 hours to get from coast to coast, at a cost of 6 cents an ounce, took 32 hours in 1926 and averaged 24 cents an ounce.

Air mail was so profitable that few contractors bothered to install seats in their planes. But some pioneer travelers consented to ride in open cockpits or sit on mail sacks. Later they crowded into boxlike cabins.

Drills Screech, Rivets Gouge Clatter as Workers Assemble the Fuselage of a DC-7

[illegible]

The first regularly scheduled passenger service by an air-mail carrier was inaugurated [illegible] by Western Air Express [illegible] Western Air Lines. [illegible] carried about 1,000 pounds of mail and two passengers over the 600-mile route from Los Angeles to Salt Lake City.

On July 6, 1926, the first air transport company primarily engaged in passenger business established service between Washington, D. C., and Philadelphia. By the end of 1927 many pioneer transport services were operating, including one to Latin America.

With [illegible] and faster planes, transitored, each [illegible] up to 14 passengers. The year 1933 saw the introduction of an all-metal, low-wing, two-engined transport, the Douglas DC-3, which became the work horse of the fleet.

Law Stimulates Civil Aviation

To regulate and promote the scheduled airlines in the public interest, Congress passed the Civil Aeronautics Act in 1938. It was a remarkably fine piece of legislation. Scheduled airlines moved forward under this new directive. Passengers increased and cargo carrying by air developed.

On the day Pearl Harbor was attacked, the military turned to the scheduled carriers for help. Approximately half their fleet of 359 transports and 27 flying boats and half their personnel, 7,300 employees, went to work for Uncle Sam within six months.

After World War II new 5-mile-a-minute, 50-passenger aircraft made their debut. As these planes settled into routine service, a new degree of efficiency was achieved.

Then, once again, there were war rumblings, and the airlines answered another call to the colors. Three days after the Korean War's outbreak they made available 40 of their largest planes to the United Nations effort.

During the height of fighting, commercial aircraft were carrying 67 percent of passengers, 56 percent of cargo and 73 percent of all mail flown to the war theater. Thanks to the airlines, the Military Air Transport Service (MATS) was able to meet its other obligations in the free world (page 722).

At present the scheduled airlines are bringing direct passenger, mail, and cargo service to 687 cities in the United States at rates far cheaper than in the old days. For instance, in 1926 the average passenger fare was 12 cents per mile; today it is 5½ cents.

Earlier I outlined the air transport picture as we believe it will look during aviation's second half century. Now let's sketch in the details and consider some of the problems.

These problems are enormous, particularly in the matter of jet transports.

For many years American manufacturers have dominated the international market with their highly refined, piston-driven machines. At present about 80 percent of the world's transport planes are American-built. But recently we have seen the very capable British enter the competitive scene—jet-propelled.

For more than a year the government-owned British Overseas Airways Corporation has been operating jet powered de Havilland Comet I's (page 730).

Three improved versions of the Comet, the Series II, III, and IV are planned.

Meanwhile, other British aircraft manufacturers have not been idle. Vickers, Avro, and Handley Page say they will introduce giant high-speed jet transports. Moreover, both Vickers and Bristol have built medium-range turboprop airliners. Other, larger British turboprops are in the planning stage.

In contrast, American manufacturers have yet to produce a jet transport.

Douglas, Lockheed, and Boeing plan jet airliners, and Boeing will be ready to test-fly a prototype in the summer of 1954.

Consolidated Vultee has converted several of its familiar Convair-Liners to turboprop operation and has sold two such aircraft to the United States Air Force. Similarly, Lockheed is experimenting with turboprop installations in its Super Constellation.

But that's the extent of our activity to date. Obviously, British manufacturers and airlines are ahead of us in the race for commercial supremacy in the Jet Age. Their lead, I believe, is confined to jet plane airframes, not power plants.

Nevertheless, how did it come about?

Long-range Planning Helped British

The explanation lies in the basic difference between British and American civil aviation and in the nature of the jet engine itself.

Britain's new airliners, though designed and built by private firms, found their inception after World War II in government-sponsored, long-range planning for civil aviation development. Actual production was assured by orders from the Ministry of Supply and the government-owned airlines.

In short, government help gave the British a head start in jet commercial development. This statement is in no sense a reflection upon our overseas cousins. They approached the jet problem with characteristic energy, initiative, and imagination.

However, the situation of our own highly competitive aircraft industry was quite different. Airlines supported a legislative proposal in 1948 that the Government sponsor a jet-liner prototype, but nothing came of the suggestion. Lacking government help, and an

A Super Constellation Passes Past Lower Manhattan's Towers

[illegible]

[illegible]

assured backlog of orders, manufacturers were not in a position to gamble upon an early venture into the jet field.

Several makers were smarting under sharp losses incurred in the development of conventional transports. The cost of building a jet prototype, estimated at [illegible] 1,000, was reason for pause.

[illegible] manufacturers and airlines alike were concerned over the high cost of jet operation. One 4-engined DC-6B [illegible] per mile of fuel per mile. A jet transport of the same size would [illegible] 3,3[illegible] pounds.

At low altitudes [illegible] a matter of concern to the business-managed, private enterprise airlines. One present [illegible] when about to [illegible] with passengers. [illegible] time to remain competitive and continue to improve their service, the load factor for jets must be comparable.

[illegible] transport development.

Refinements in jet engine design here in the United States have brought somewhat better fuel economy. [illegible] look, more than any other [illegible]

has prompted American manufacturers to risk the enormous sums needed for jet transport development.

Early in the planning phase the Air Transport Association laid down certain requirements for these new aircraft. They would have to be safe and dependable; have sufficient range for transcontinental and transoceanic travel; be able to land and take off at existing airports; and be as profitable to operate as existing 4-engined transports.

Some manufacturers say they can meet these requirements. On one point, operating profit, many airline officials are dubious. But there is no doubt that jet transports will be part of the American scene.

One United States airline, Pan American, has ordered three Comets (Series III models) for delivery in 1956 and has an option to buy seven more. So far, other carriers are waiting to see what our own manufacturers produce. Boeing's jetliner may be in production by 1956. Douglas and Lockheed jets probably will be somewhat later.

Since World War II the scheduled airlines have bought and paid for 1,193 piston-type airplanes, some costing as much as $1,000,000 each. Orders for an additional 226 have been placed for 1953–55 delivery.

Now comes the jet, bearing a probable price tag of about $4,000,000 each for early production models. The airlines expect to acquire approximately 100 of these planes during the period 1955 to 1960. Over the next 10 years we may have to raise more than $1,000,000,000 for all types of new aircraft: turbojet and turboprop transports, air freighters, local service aircraft, and helicopters.

We are prepared to do this, but readers should not expect conventional aircraft to disappear for a good many years. New planes, for both financial and operational reasons, must be introduced gradually.

Turboprop Planes in Design Stage

To date the United States has devoted far more research to the jet than to the turboprop, largely because of military considerations. But the gap between the two narrows.

The turboprop shows much promise as a transport plane and its development is now being pushed. Several manufacturers have commercial designs in the planning stage. Company spokesmen predict that this type of plane eventually will be more economical than any large transport aircraft now flying.

Like piston-driven aircraft, the turboprop upon landing will be able to retard speed by reversing the pitch of the propeller blades. This advantage is denied the jet, which will require longer runways.

However, there is no truth to the oft-repeated rumor that jetliners cannot use existing airports. They will take off and land with complete safety from our larger terminals. Early models will have improved braking developed for the military. Doubtless the future will see the perfection of reverse jet thrust, the ultimate in braking efficiency.

Although no jetliners have been delivered to airlines in this country, jetliners have maintained regular coast-to-coast schedules for more than a year. No passengers ride them, and not a single eye sees the propellerless giants streak overhead.

They are United Air Lines' "Paper Jets," make-believe aircraft dispatched daily on hypothetical sprints between New York and San Francisco. Meteorologists and dispatchers plan and schedule these flights just as they do regular operations.

The Paper Jets are United's own design, planned to carry 70 to 80 passengers, a crew of five, and 8,000 pounds of cargo, to cruise at 530 miles per hour at 40,000 feet, and to land on present runways at New York, Chicago, San Francisco, and alternate airports.

Conditions Good for Jet Flights

By preparing flight plans with jet capabilities and requirements in mind, United has gained valuable information on problems the airlines will encounter in actual jet operation, particularly with respect to high-altitude weather conditions and airport traffic.

United says its studies indicate conditions in this country generally are favorable for commercial jet flights.

Five years ago the introduction of jets on a large scale would have been extremely difficult because of airport traffic conditions. Navigation and traffic-control facilities simply had not kept pace with the development of the aviation industry. Foul weather canceled many flights. Planes often had to circle above an airport in "holding patterns" for many minutes because of bad weather and antiquated ground-control equipment.

This is the problem known as "stackup." It would be acute in jet operation because of the engines' ravenous appetite for fuel at low altitudes. Fast new transports will have adequate fuel reserves for any eventuality, but they would hardly be economical if long landing delays were encountered frequently.

Fortunately, stackup is being eliminated as a major problem, thanks to pioneering work in electronics by many organizations.

Until recent years pilots flying the Federal airways navigated primarily by means of low-frequency radio signals from ground stations. Chief among a number of disadvantages were two: the signals could not be broadcast in all directions, and frequently they were

Passengers Arrived in New York Await Shuttle Service by Helicopter

New York Airways is promoting the use of helicopters [illegible] Air Europe passengers use the [illegible]

Britain's Jet Guided Missiles Alarm Cottonseed Friends

[illegible]

[illegible]

[illegible]

[illegible]

53.

Roundup Time in Texas Helicopter Style

[illegible]

[illegible]

obliterated by the buzz and crackle of static.

Today the Civil Aeronautics Administration is rapidly replacing this equipment with two new radio aids. One, known as distance-measuring equipment, operating in the ultra-high frequency band, automatically determines a plane's distance from a known geographical point. The other, called omnirange, in the very high frequency band, sends out course signals over a full 360-degree circle. Together they determine the plane's position. Both are virtually static free because of the frequency bands in which they operate.

At airports the CAA is installing many new aids, among them high-intensity lighting, improved radio instrument landing systems, surveillance radar, and precision approach radar.

A number of years will be required to complete the installations on a nationwide basis. But marked improvement at major airports already is evident, paving the way for jets.

These new devices are considered only transitional in air-traffic control. Already planned are machines, operating on the radiotelotype principle, which will eliminate voice control in ground-to-air communications. Pilots will receive instructions on tape from electronic devices in the crew's compartment. Built-in safeguards will prevent the devices from transmitting a confusing or dangerous order.

Flying by Robot Control

The next logical step leads to the ultimate in airplane control, fully automatic flight. It is, of course, many years away, but CAA spokesmen and a number of other aviation leaders see it in the future picture.

Here, in general terms, is how it will work.

Ground crews, after preparing a step-by-step sequence of events for your flight, will put the information in code on a punched card. The pilot will feed the card into an electronic programming device, then sit back and watch as the ingenious robot goes to work.

It will take your plane off along an airport radio beam, switch to various omnirange stations while navigating you to your destination, then land your plane according to terminal approach and glide radio beams. Throughout your flight the robot will control the throttles and the plane's automatic pilot.

In recent years civil aircraft equipped as flying laboratories have made partially automatic flights, but much work lies ahead before the system is entirely safe and feasible.

You can be sure the robot will not replace your trusted, efficient human pilot. Mechanical brains, though they minimize the possibility of human error, cannot cope with emergencies or changes in flight plans. Man must monitor the equipment and be ready to assume manual control of the aircraft when necessary.

Today there are some 50 applications pending before the Civil Aeronautics Board for certificates to inaugurate helicopter routes.

Three companies actually are in scheduled operation. New York Airways carries mail, cargo, and passengers between three New York City airports: International, La Guardia, and Newark (page 735). It also flies regular runs between communities in New Jersey, New York, and Connecticut. Los Angeles Airways has a similar operation, and Helicopter Air Service transports mail in the Chicago area.

As yet these operations are small, but they promise to burgeon. Growth awaits big multi-engined helicopters. Such machines, developed for the military, will be rolling off commercial production lines in 1955-56, and fleets will be available by 1959 or 1960.

So promising is the outlook that operations departments of scheduled airlines contemplate a test program in which multi-engined helicopters will be used in round-the-clock operations. Details are being worked out.

Heliports: Where to Put Them?

One problem in particular looms large in the operation of rotor aircraft—heliports. Where will they be located in downtown areas? What will they look like?

Proposals are many and varied. Helicopters may operate from ground-level lots surrounded by terminal facilities. Others may fly from platforms atop reinforced roofs of office buildings. Many undoubtedly will use low-level facilities built above water.

To me this latter method seems the most promising. It has already been adopted by the Port of New York Authority. Engineers have bridged two piers along Manhattan's East River and now are constructing a heliport atop the platform. A water approach guarantees unobstructed flight paths.

Flight obstruction will be a serious problem in rooftop heliports. For instance, suppose you were operating helicopters from the roof of a 4-story building, the highest in the neighborhood. Then one day the owner of the building next door decided to tear it down to make way for a 20-story structure. If the new building obstructed your flight path, you might be put out of business in that locality.

Here is a problem not only for airline people but for real-estate specialists. Ironclad covenants and municipal legislation involving building heights will have to be worked out in many communities before rooftop heliports can be used extensively.

Basically, however, the idea is good. Helicopters can land on roofs just as easily and safely as on vacant lots. Passengers would buy tickets in the building lobby and then

World's Largest Transport Helicopter Built for the Air Force, Dwarfs Older Models

[illegible] Sikorski also builds the H-21 [illegible] and the HUP-[illegible]

[illegible] would be a problem close to a heliport. But downtown locations can [illegible] not [illegible] to operate. Also, [illegible] more [illegible] to [illegible] noise. Muffling of large-powered aircraft engines is not yet practicable for economic reasons, but experts are working on the problem.

Helicopter Ideal for Short Hauls

Frankly, today's fixed-wing aircraft are not designed to compete effectively with surface transportation on trip lengths of 60 to 140 miles. Airlines generally lose money carrying people [illegible] Moreover, [illegible] facilities usually lie outside cities.

These circumstances have weighed heavily [illegible] the growing number of air taxi operations serving small communities.

[illegible] helicopter [illegible] for some local lines, particularly those [illegible] serving large [illegible] short-haul transportation market.

[illegible] Congress [illegible] Wright [illegible]

[illegible] Congress of the Air [illegible] Wright [illegible]

Today the aviation industry is blessed with many young men who possess the elements of genius, who are resolute, who are spurred on by faith. [illegible] are the spiritual heirs of the brothers Wright.

[illegible] will continue the transformation of our world [illegible] Jones.

• The NATIONAL GEOGRAPHIC MAGAZINE published its first article on aeronautics, "Tetrahedron Proof of [illegible] June, [illegible] more than 150 articles on aviation subjects. Among [illegible] as Rear Admiral Richard E. Byrd, Col. Charles A. [illegible] For a complete list of aviation articles, see the [illegible] Index, 1899-1959.

Kitty Hawk, North Carolina, December 17, 1903. Man's Dream of Flight Comes True

Ice coated the rain pools and a bitter wind whipped the sand dune of Kill Devil Hill. Two brothers—Orville, 32, and Wilbur, 36—launched with a frail contraption of wood, muslin, and wire [illegible] a dual de Havilland, aircraft with a gasoline engine, on an iron-shod rail [illegible]

[illegible] then rushed; two propellers turned. The *Flyer* moved slowly into the wind. Wilbur Wright [illegible]

[illegible] the machine stood aloft. It was man's first successful powered flight in a craft [illegible] on that fateful December day 50 years ago, the contraption flew three times [illegible] seconds and 852 feet. The Wright brothers, after four years of patient [illegible] that man had coveted since he first watched the birds [illegible]

[illegible] an auspicious event came so unheralded. The Wrights [illegible] flown dozens hundreds of times, they were completely convinced [illegible] fully understood the drama of the occasion. Most newspapers refused to carry the [illegible] and inaccurate account. It was years before the American public [illegible] and gave to the Wrights the credit due them. page 74

[illegible] Orville Wright presented this photograph [illegible] Gramercy staff. Wilbur [illegible]

Wilbur, having won a coin toss, attempted a flight December 14, three days before Orville's triumph. He [illegible] on Dune Hill of 1903, which damaged many of the Wright machines.

12

"Are They Birds or Bears?"
The Wrights Prove Their
Case at Fort Myer

[illegible]

Photo

* Powered Aviation Suffers Its Least Fatality: Lt. Selfridge, U. S. Army, Dies in Fort Myer

[illegible]

* Evening sky silhouettes the Wright flyer circling Fort Myer in a successful 1909 demonstration.

▸ John A. D. McCurdy Pilots *Silver Dart* Over Baddeck Bay, Nova Scotia, February 23, 1909—First Airplane Flight in Canada and British Empire

While the Wrights prepared to demonstrate their *Flyer* to an owner Europe, another group of pioneers was building and flying planes at Hammondsport, New York, and later at Baddeck. This was the Aerial Experiment Association, organized by Dr. Alexander Graham Bell and financed by Mrs. Bell.

The illustrious inventor of the telephone had experimented for years with enormous tetrahedral kites, trying to find the proper design for a powered heavier-than-air craft. Becoming [illegible] the inventors joined him in 1907: F. W. Baldwin and John A. D. McCurdy, young Canadian engineers; Lt. Thomas E. Selfridge (origin [illegible]); and G. H. Curtiss, a top cycle racer and manufacturer who was called "fastest man [illegible]." [illegible] these men built and flew [illegible] all equipped with [illegible] kite cells. McCurdy designed [illegible] the Association's four planes.

The [illegible] associates devised a biplane wing, up a kind [illegible] [illegible] the United States [illegible] Wrights' method of [illegible] and [illegible] However, the Wrights [illegible] patented the basic principle of their wing-warping [illegible] and the court [illegible] them.

Although the Association disbanded in 1909, it had a profound influence. Curtiss went on to [illegible] first records and for years and [illegible] and manufacturer.

Dressed in Tweed and Sleeveless Coats, Men Prepare to Make History's First Ice Take-off

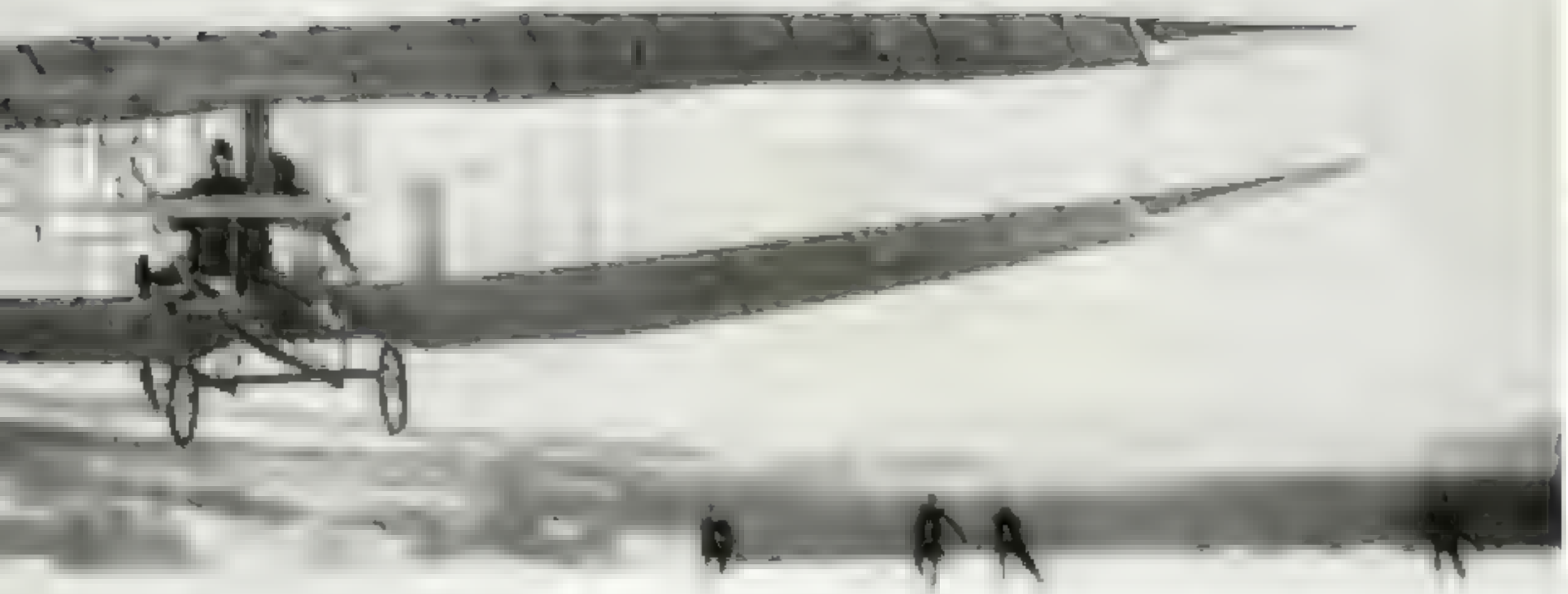
[illegible] taking place on [illegible] Bay on the morning of February 23, 1909. Nearly 150 citizens of [illegible] gathered [illegible] to witness the proceedings. Presently a sleigh glided across the ice towing the latest product of the group of inventors who worked [illegible] Bell's place, Beinn Breagh, which overlooks the bay. Instead of [illegible] the new plane had a [illegible] wheel underneath [illegible] its wings turned.

While Dr. Bell and the others watched, *Silver Dart* sped across the ice, kicking up a cloud of snow as it took to the air. With John A. D. McCurdy at the controls, it flew across the wintry landscape for half [illegible]

McCurdy, today the senior living pilot in the Commonwealth, can lay claim to a long string of [illegible] achievements. While working with Dr. Bell and the Aerial Experiment Association he became the sixth man in the United States to get a heavier-than-air machine [illegible]

In 1910 McCurdy won the world's [illegible] International Aviation Meet, in Belmont Park, New York. [illegible] first wireless from a plane aloft, the message going to the New York *Herald*. In 1911 [illegible] Long Beach Parade he received the first wireless from [illegible] to aircraft.

McCurdy [illegible] at premier aviation meets in Mobile, Atlanta, Norfolk, San Diego and Pensacola. The Mobile [illegible] reported on November 27, 1910: "McCurdy blew up a battleship [illegible] he would have [illegible] he dropped in there from his aeroplane had been filled with nitroglycerin and it [illegible] lying on the ground in front of the grandstand [illegible] have been the funeral of a [illegible] McCurdy served with distinction [illegible] Nova Scotia.



Lieutenant McCurdy Prepares to Dare the Shark-infested Crossing from Key West to Havana

[illegible]

Teleboys Circles a Pylon in Aviation's First International Meet, Reims, France, 1909

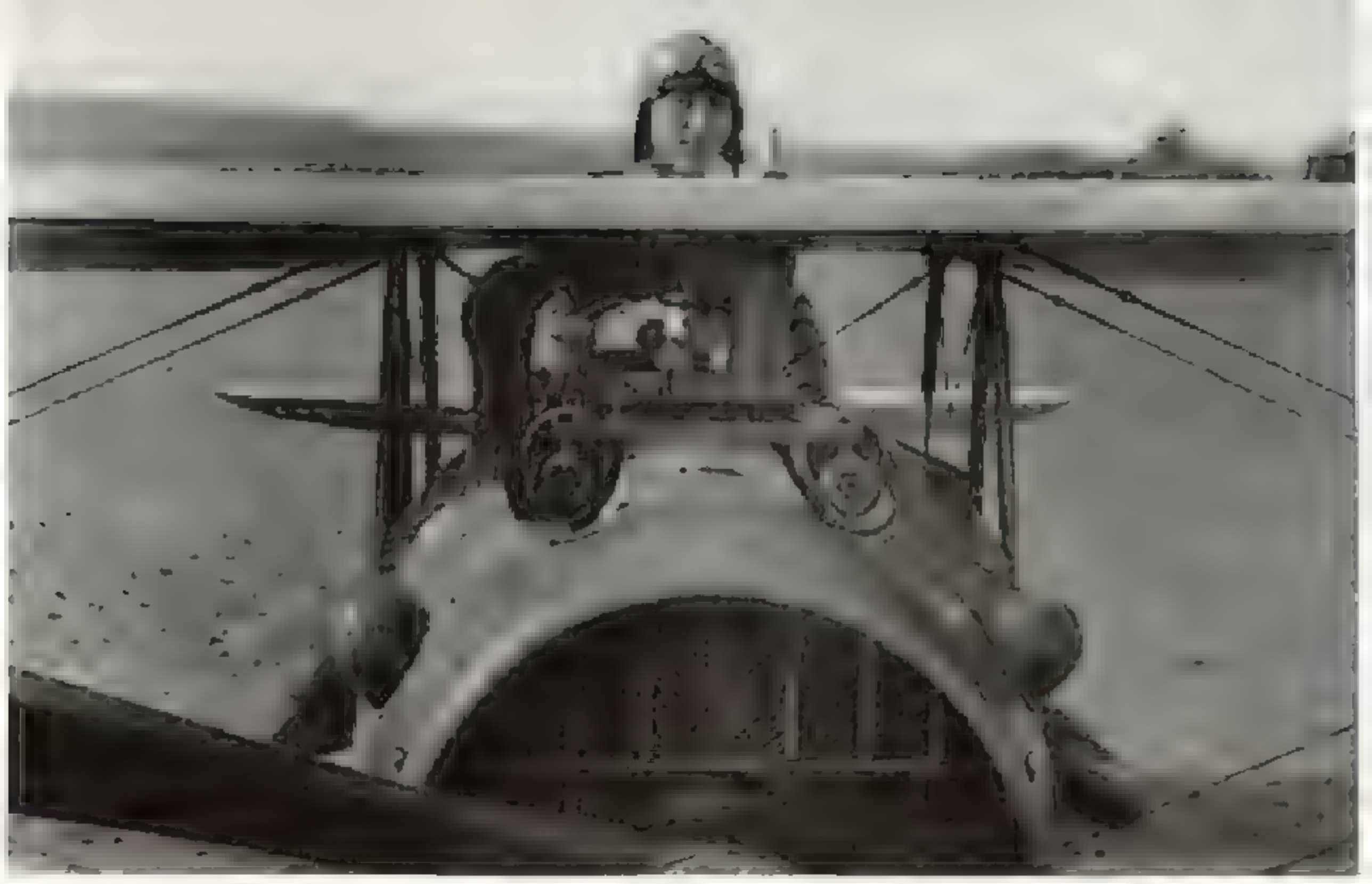
Dover's Cliffs Great and Noble as Louis Blériot Spans the English Channel

Sailors on Masts Watch Eugene Ely Land on History's First "Airplane Carrier"

[illegible]

First Transcontinental Flight: Vin Fiz Flyer Advertises a Drink

[illegible]

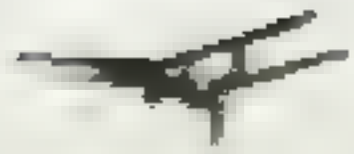


• Rickenbacker, America's Ace of Aces in World War I, Leans over the Spad

[illegible]

• Commander-to-be of Army Air Forces Pilots a Wright *Flyer* in 1912

[illegible]



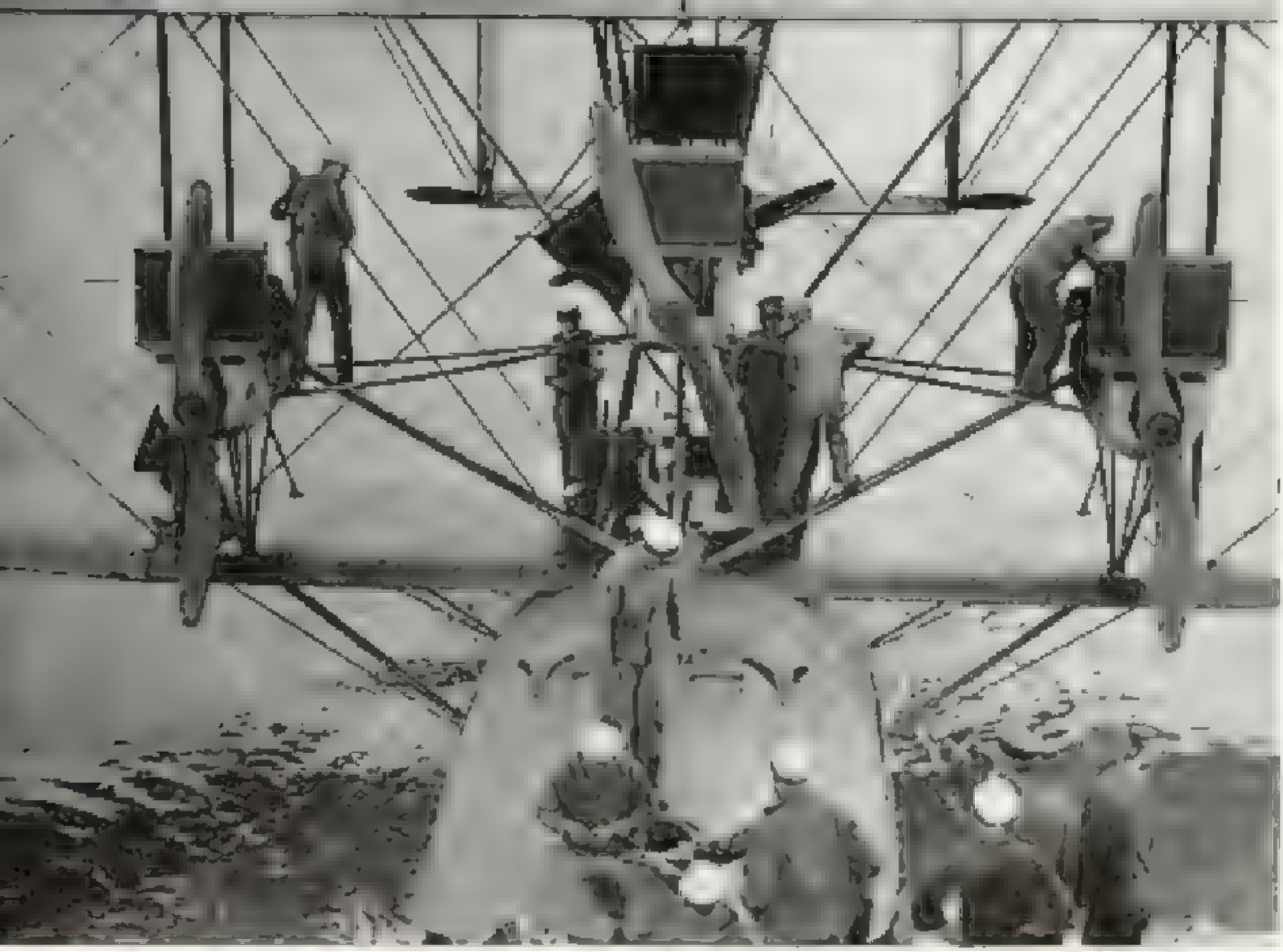
Langley's Aerodrome Proves the Possibility of Mechanical Flight

Santos-Dumont, in France, Mistakenly Thought His Plane Was First to Fly

[illegible]

1917: Royal Flying Corps Pilots Learn to Catch Jerries

[illegible]



Navy and Army Dare an Ocean and Girdle the Globe

[illegible]

Admirers Mob Amelia Earhart After Her Nonstop Flight from Honolulu

[illegible]

England to Australia: Ross Smith Completes a Record-Breaking Journey in 1919

[illegible]

Richard E. Byrd:
First to Fly
Above the Poles

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

A Man, a Plane, and an Ocean:
Lindbergh Flies New York to Paris

Four Decades of Air Progress: A Sabrejet Whistles Past a 1912 Pusher

When peace comes, thousands of men and thousands of planes will be required for the mail service of the [illegible] the air, for aerial coast patrol, for aerial map making by means of aerial photography, for explora[illegible] transit of passengers and freight. When Rear Admiral E. Peary made this observation in January 1918 [illegible]

[illegible] forecast was made at a time when a flight from Chicago to New York was dismissed for its hazards; [illegible]

[illegible] advanced in understanding the art of flight is strikingly illustrated by these two planes [illegible] Accorna. Billy Parker's half-ton Curtiss was built chiefly by hand. North American's 7-ton F-86 [illegible] was produced on the assembly line from 14,000 parts. The 1912 pusher biplane draws on 80 horsepower [illegible] a mile a minute. Sabre's General Electric turbojet engine delivers nearly 6,000 pounds of thrust, equal to [illegible] forces and backdrops, Sabre's pilot rides a pressurized cockpit to 45,000 feet and more [illegible] 1,200 miles an hour. At these supersonic speeds, friction generates [illegible] up to 400° F. on the plane's skin. Most metals creep, and their strength steps away (page [illegible])

As man [illegible] interplanetary flights, he cannot help pondering Orville Wright's words [illegible] have been preserved for so many years past [illegible] but we could discover them!

A Little Box-in-a-box Wind Tunnel Made Possible the Wrights' First Flight; Now Screaming Supersonic Winds Test Weird Shapes of Aeronautical Things to Come

By Hugh L. Dryden

Director, National Advisory Committee for Aeronautics, and
Life Trustee of the National Geographic Society

With Photographs by Jack Mardon, National Geographic Staff

THE [illegible] progress has two aspects, one in the public view and familiar to all, the other more subtle.

The first is a succession of new and improved aircraft which establish the ascending series of performance records described in the daily press. Here are exploits by the spiritual descendants of Orville and Wilbur Wright, who transformed man's vision of human flight into reality at Kitty Hawk, North Carolina, on December 17, 1903.

The second aspect of aeronautical progress is the growing store of human knowledge that underlies and makes possible the practical accomplishments. This foundation is continually being deepened and broadened by research in the aeronautical sciences.

First Plane "Born in a Box"

The practical achievements of the Wrights were made possible by their own less-known activity in the field of research. Without it they could not have flown at all.

"Except for what we learned from our wind-tunnel experiments in 1901, we never could have built wings that would lift the machine and pilot with the amount of motor power then available," Orville Wright explained.

Their tunnel was little more than a box about as long as a coffin and 16 inches wide and high, with a fan that stirred a 27-mile-per-hour wind. But it proved that earlier tables of wind pressure were wrong and enabled them to design the wings—curved, or cambered, instead of flat—that first lifted men from Mother Earth in a powered, heavier-than-air plane. Thus the first successful plane sprang like a genie from a little box with a feeble fan at one end (page 765).

On this Golden Anniversary it seems appropriate to review this second aspect of aeronautical development, with which I have been associated all my life, and to assess our present position and the direction in which we are moving.

The airplane and I grew up together. Fifty years ago, when Orville and Wilbur first flew, I was five years old. I remember well the first airplane I ever saw. It was an Antoinette monoplane flown over Baltimore in 1910 by Hubert Latham, brilliant aviator, pioneer sportsman, and big-game hunter, who lost his life a year and a half later, not in an airplane but on the horns of a wounded wild buffalo in the French Sudan.

The flight and the accompanying discussion in the press stimulated me to my first aeronautical paper at the age of 12. Under the title "The Advantages of an Airship over an Aeroplane," I set forth that in the case of the airplane "the least break in the machinery will hurl the aviator to the ground" whereas "the airship has a gas bag to support it." I continued that "airships have the advantage of carrying many passengers, but the aeroplane can only carry one."

These statements, and the general conclusion that "the airship has the greater advantage for commerce and exploration, while for the sportsman the aeroplane would be the better," have been shown to be false by developments of the first half century, but my paper reflected the currently held views.

The Antoinette monoplane, designed and built in France, weighed about 1,250 pounds when fully loaded. Its maximum speed was 47 miles per hour. The engine was an 8-cylinder V type of about 50 horsepower.

Thus the first airplane I ever saw had four times the power of the original Wright plane, nearly 70 percent greater weight, and 50 percent higher speed. So much had the art advanced in seven years.

Speed Hits 1,238 Miles an Hour

By the time I made my first flight in an airplane—at Washington, D. C., in 1919—further great strides had been made. The plane was a Curtiss Eagle, piloted by Bert Acosta. This 8-passenger "aerial limousine, with plywood cabin giving full protection from wind, and reduction of noise so as to permit conversation," was one of the first American trimotored airplanes, powered by three Curtiss engines of 150 horsepower each. The weight was about 7,500 pounds and the maximum speed 107 miles per hour

Glowing Warplanes Play a Serious Game of Hide-and-seek in Desert Skies

As compared with the Antoinette monoplane of nine years earlier, the Eagle biplane had more than double the speed, nine times the power, and six times the weight.

From these beginnings I have seen developments proceed along many lines. Some such as the Diesel-engined aircraft and the Autogiro, have faded and died; others, such as jet propulsion and the helicopter, have surged forward in expanding accomplishment.

Speed has reached an amazing 1,238 miles per hour in the Douglas Skyrocket, an airplane developed for high-speed research under a joint military-industry National Advisory Committee for Aeronautics program.

Gross weight has reached 358,000 pounds in the Convair B-36H bomber, with the equivalent of more than 44,000 horsepower at a speed "exceeding 435 miles per hour."

Our Navy's F4D, the Douglas Skyray jet fighter for carriers, averaged 753.4 miles per hour in four passes over a measured course on October 3, 1955 (page 768). This surpassed records set in rapid succession by the U. S. Air Force's North American F-86 and Great Britain's Hawker Hunter and Vickers Supermarine Swift. Our North American F-100 [illegible]

The British are pioneering in the field of turbojet transport, and their Comet cruises at nearly 500 miles per hour (page 756).

It's a Rare Plane That Knows Its Father

These present and all future generations of aircraft embody the cumulative total of knowledge in many fields of science and technology. Just as tracing a person's family tree leads to awareness of an ever widening chain of ancestors whose genes have contributed to his physical and mental make-up, so each new aircraft reflects the research and experience of hundreds or even thousands of people at many institutions in many countries.*

For a number of years after the first flight, it was possible for any individual to [illegible] there was to be known about aeronautics or aircraft design. As recently as 1915, when I was working for my doctoral degree, I was assigned the task of reading and summarizing the knowledge of the physical principles employed in aeronautics.

The situation soon changed. Today it would be very difficult, if not completely impossible, for any one man to design a plane. Our new airplanes are the final product of a large organization of many specialists.

Much of our present work is secret, but here are some examples from the past:

During World War II the Germans captured one of our P-51 Mustang fighters and measured its performance. They were astounded because their tests showed that "the Mustang is far superior aerodynamically to all other airplanes." The Mustang wing was of a type first developed at the NACA in the years just before the war, a type known as laminar-flow wings. The NACA has designed and tested many "families" of wing sections, and most airplanes now flying use wing shapes of one of these families.

In early planes, including Lindbergh's *Spirit of St. Louis*, the engine cylinders extended freely into the wind stream, giving effective cooling but high drag. Research begun in 1927 led to the development of a metal cover over the engine—commonly known as the NACA cowling—which gave satisfactory cooling and greatly reduced drag.

In 1932 the NACA reported the results of a study to determine the best location of the cowled engine nacelle, and this location is still used in all modern piston-engined transports.

Newton "Proved" Flight Impossible

If any field of science is to be considered dominant in aeronautics it is aerodynamics—the study of the flow of air and the forces exerted on bodies moving through it. In such research our goal is to determine the best external shape of the airplane to give the desired lifting force with minimum drag and to provide satisfactory stability and control.

Isaac Newton in 1687 regarded air as made up of small particles moving independently. According to a formula he devised for determining the force of the wind on inclined surfaces, mechanical flight was impossible.

Early experimenters interested in the probability of flight tried many methods for measuring the lifting power of the air. Some such as Otto Lilienthal in 1889, mounted surfaces of different shapes on scales and exposed them to the breeze. Others dropped models from high structures such as the Eiffel Tower or mounted them on cars or whirling arms. But natural wind is notoriously fickle, a large volume of still air is hard to find, and the moving car or arm produces disturbing air currents; so these methods have been abandoned except for special purposes (page 761). Best for most tests is man-made wind blowing through a tunnel (pages 763, 769, 774, and 775).

The first wind tunnel of which we have record was designed by F. H. Wenham about 1870 as an activity of the Aeronautical Society of Great Britain. It was 18 inches square, 10 feet long, and equipped with a 30-inch fan. The models were one foot square, and we now know they were too large in rela-

* See "New Frontier in the Sky," by F. Barrows Colton, NATIONAL GEOGRAPHIC MAGAZINE, September, [illegible]

NACA
TEST
NACA III

• Scorpion Plays Coasters on Dive Bombers From Planning Wing-tip Pods

• This Rocket-shaped Model Will Fall 7 Miles

tion to the tunnel size to give accurate data.

Today the wind tunnel has become our most valuable research tool, and its growth in size and power matches the tremendous advance in performance, size, and complexity of planes.

Wind tunnels vary greatly in size and speed. Some have test sections only a few inches across, with wind speeds up to 6,000 miles per hour. One has a test section 40 by 80 feet through which the wind roars at a speed of about 250 miles per hour (page 764).

The wind tunnels now most in demand for NACA tests of the final design shape of our newest airplanes are the transonic tunnels with winds of about 760 miles per hour, the speed of sound at sea level. At transonic speeds the air flow is mixed, part slower than sound, part faster than sound. We still lack the mathematical means for predicting aerodynamic behavior in the transonic range and therefore must get our information experimentally.

Wind tunnels providing transonic and supersonic test speeds require large amounts of power. The largest of the NACA's supersonic tunnels (at the Lewis Flight Propulsion Laboratory, Cleveland) has a test section 6 by 8 feet and an operating speed twice that of sound. It is powered by three electric motors with a total of 87,000 horsepower.

Under construction today at NACA laboratories and at the Air Force's Arnold Engineering Development Center, Tullahoma, Tennessee, are five larger supersonic tunnels. One will reach a speed five times that of sound, or more than 3,000 miles per hour. Each of these will be powered by electric motors of more than 200,000 horsepower.

These supersonic tunnels must be heard and seen to be appreciated. As long ago as 1923 I was experimenting with propeller tip sections in a sonic-speed jet of air at General Electric's Lynn, Massachusetts, plant. Afterward when my colleagues and I walked out into the streets, we noticed that passers-by seemed unusually interested in our group. We later realized we had been unconsciously talking in very loud tones to compensate for the temporary deafness caused by working for several hours with our heads a few inches from a 12-inch sonic jet.

Tools Include Supersonic Rockets

Modern aerodynamic research uses other tools to advance our knowledge of transonic and supersonic flight. At the NACA Wallops Island station, on the Atlantic coast just south of Chincoteague Island, of wild pony fame, models of airplanes and missiles are propelled to supersonic speeds by rockets (page 778). Instruments in the model automatically radio the data we need.

Still another experimental method led to the first supersonic flight by man—by Capt. (now Major) Charles Yeager of the U. S. Air Force in the Bell X-1 at Edwards Air Force Base, California, on October 14, 1947. This method is the use of special research airplanes to provide experimental data beyond the range of performance attainable in tactical military or commercial planes (pages 766, 771).

Some of these planes, such as the rocket-powered Bell X-1 and Douglas D-558-2, are carried aloft by mother aircraft to conserve their fuel for brief moments of high-speed supersonic flight at high altitudes. Thus we can explore ever-new frontiers of higher speeds and altitudes, gaining information needed for designing tactically useful supersonic planes.

The NACA has extensive installations at Edwards, on Rogers (Muroc) Dry Lake.

High Speeds Bring "New-look" Planes

The pilots of military aircraft at the beginning of World War II discovered in practical flight what aerodynamic research workers had known long before—that speeds approaching that of sound introduce new problems and a need for different external shape.

At such speeds, air no longer flows freely but piles up ahead of the plane. Shock waves appear, and the drag of the best subsonic shapes increases enormously—so much so that the speed of sound came to be regarded as a "sonic barrier" (page 774). Planes became unstable and went out of control, sometimes with fatal results, when compressibility effects were first encountered.

For the new high speeds made possible by jet and rocket power, drastic changes had to be made in aircraft designs. Some of these "new-look" planes are pictured herewith.

As a member of a special team from the U. S. Air Force Scientific Advisory Board, I spent V-E Day at the secret German aeronautical research laboratory at Völkenrode near Braunschweig. There we saw planes and models with sharply swept-back wings—like those of our present F-86—and many reports on this arrow-wing, or *Pfeilflügel*.

At the time, I was a member of the staff of the Bureau of Standards and did not know that R. T. Jones of the NACA had independently realized the advantage of sweepback for sonic speeds and had made tests in wind tunnels to verify his theories before the German information was available.

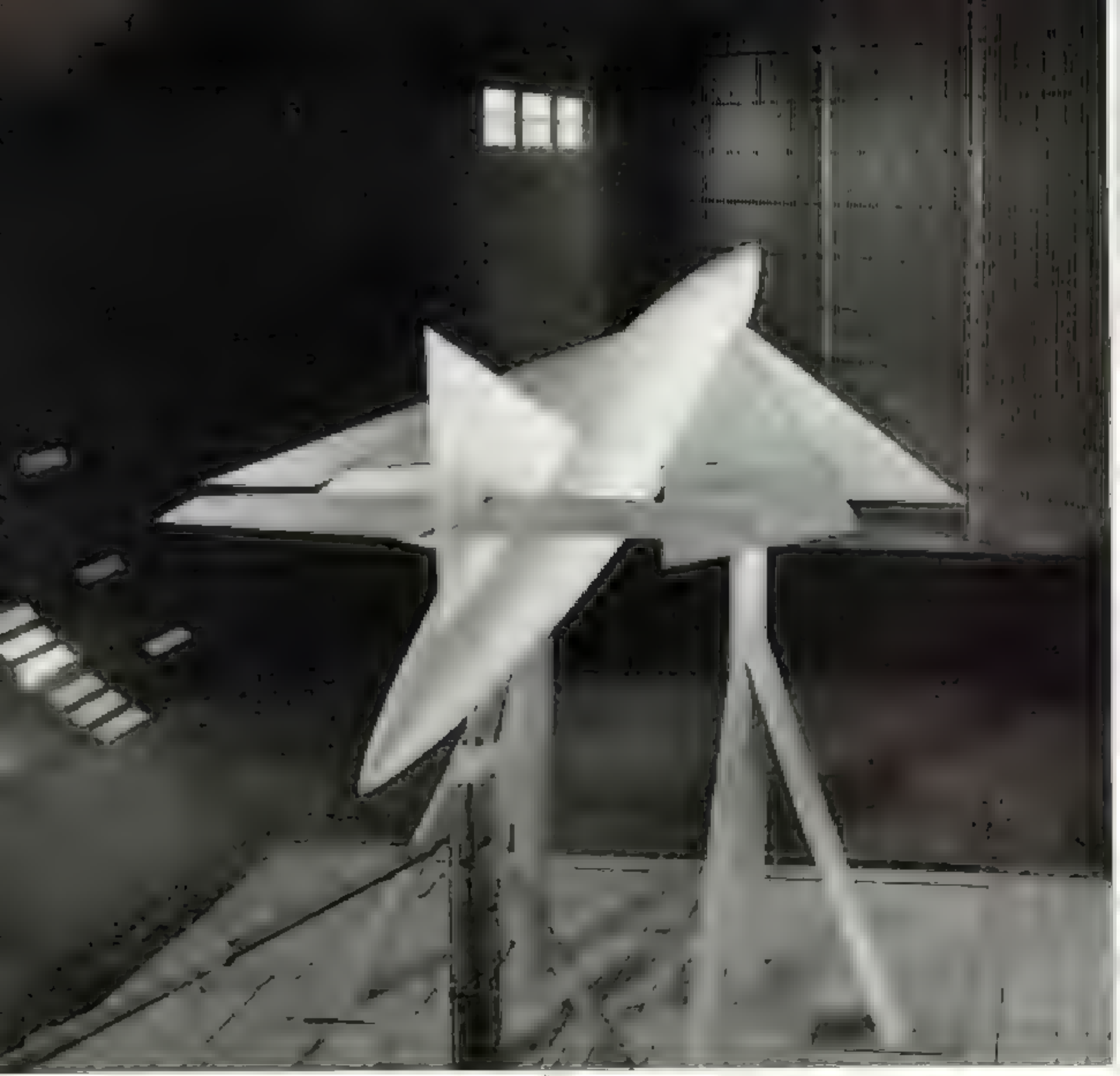
Another new shape is the triangular, or delta, wing, and we shall probably see additional airplanes using this configuration (p. 764). As higher supersonic speeds are attained, still other shapes will appear. I believe, for example, that wings will be shorter and wider, smaller compared with the body,

Flying Venetian Blind Gives Stream Lift

[illegible]

A Free-Flight Model Hangs on Moving Air

[illegible]



[illegible] and [illegible] with sharp leading edges. Most [illegible] for [illegible] and greater speeds are under study in the aeronautical research centers of the world.

The best shape for [illegible] or supersonic speed results in poor characteristics at subsonic speeds. But sky-racer airplanes must take off at [illegible] speeds and land at [illegible] speeds from [illegible] to supersonic.

Designers are solving the trouble by adding [illegible] or varying the sweep angle of the wing. It is possible by [illegible] experiments to convert this transport airplane to landing, by flaps at the back [illegible] of the wing, and in a few cases to actually varying the sweep angle of the wing [illegible].

Wind tunnel [illegible] related to aerodynamics, and computations to fit in the development of [illegible] is [illegible], which deals with the forces exerted on [illegible] moving through water. Water-borne aircraft are of great military value [illegible] Navy [illegible] types of [illegible]. [illegible] substantially [illegible] in [illegible] centers. Charged [illegible] in [illegible] and [illegible] hydrodynamics [illegible] with [illegible] water handling characteristics.

Recent research [illegible] Navy Department, [illegible] has led to the successful development of [illegible] hydrofoils, [illegible] small elongated surfaces which [illegible] water [illegible] to lift [illegible] take off on water [illegible] or [illegible]. The Sea Dart is the first high [illegible] hydrofoil-based airplane with good [illegible] range [illegible].

If the proper external [illegible] for airplane [illegible] aerodynamic and hydrodynamic knowledge is the first consideration in the design, the second is [illegible] that of the materials which make up the [illegible] and

Wooden Box to Giant Steel Tunnel: Half a Century of Flight Research

[illegible]

[illegible] into "lightweight" structures [illegible] material.

[illegible] construction [illegible] has changed but little [illegible] the Wrights. [illegible] of wood [illegible] construction. The whole was covered with canvas or linen, [illegible]

During World War I, especially in Germany, all-metal construction was developed. A new material, duralumin, [illegible] with copper and small [illegible] of other metals, was introduced by [illegible] a German, in 1909. [illegible] planes, [illegible] and internal bracing wires [illegible].

[illegible] light [illegible] for the [illegible] of airplanes, for propellers, and [illegible] parts. [illegible]

[illegible] these gases.

[illegible] airplane [illegible] and [illegible] the speed of sound or higher. [illegible] properties at high temperatures.

In [illegible] miles per hour [illegible] the strength [illegible]

At lower [illegible] speeds the material tends to [illegible] under [illegible] The metal [illegible] in the wings [illegible] Depending on the [illegible]

Spaceborneted Mouse Admires His Test Pilot Doll's 'Rear Space Suit'

We, Walter Mouse, [illegible] Test Pilot [illegible] Bell X-5 [illegible]

and load, the creep lifetime can vary between thousands of hours and a few seconds.

One older material, stainless steel, has properties suited to high-temperature applications. It has been used in experimental aircraft and in the Bell X-2 research airplane intended for research at high supersonic speed. Difficulties of fabrication are very great.

Another relatively new material, titanium, is well suited to intermediate temperatures and is coming into use, especially near the engine tail pipe of jet airplanes. At present the supply is limited and the cost very high, but rapid progress is being made in alloy development and fabricating methods.

Demand is steadily increasing, for titanium has many potential uses, not only in jet engines and planes but also in the automotive and ordnance fields. We may expect it to come into wide use in the next half century.

Because low weight is so important in designing efficient planes, the art of lightweight construction in other fields has developed almost entirely from aeronautical needs.

Once the situation was quite the reverse. In its beginnings aeronautical construction owed much to civil engineering practice in design and construction of bridges and buildings. Thus the Wright brothers were influenced by the earlier glider designs of Octave Chanute, a distinguished civil engineer and designer of railroad bridges. In early planes the structural frame carried all the load, and, like the outer walls of a building, the fabric, plywood, or thin duralumin sheet served only as a skin.

But as aircraft structural engineering matured, the thought of many pounds of material which served only as a covering became a challenge to human ingenuity. The result was a built-up structure with stiffened skin strong enough to carry the load.

Thinner Wings with Thicker Skin

In the thin wings now required for high-speed flight we use many spars or webs as stiffeners, and a thicker skin capable of carrying a larger stress.

Strength to resist steady loads is not enough. Gusts and maneuvers produce sharply varying loads. These must be measured accurately so that the necessary reserve strength, flexibility, and "fatigue strength"—strength under repeated loads—can be provided.

Preliminary studies indicate that planes flying at 20,000 to 30,000 feet encounter only one-fifth as many bumps as those operating below 10,000 feet. The coming jet transports will probably fly at 40,000 feet, where gusts will be relatively infrequent. However, during climb and descent the infrequent large gusts will produce the same or somewhat higher gust loads than those experienced by present slower piston-engined transports.

Under certain conditions, air load and structural deflection combine to cause a destructive vibration known as flutter. It is like the fluttering of a flag or the rapid buzzing of a Venetian blind in the breeze. Many engineers are busy with computations and experiments to prevent flutter of our modern airplanes and missiles.

A most difficult problem of the next few years is the structural aspect of aerodynamic heating [illegible] speeds go higher and higher. When a [illegible] missile heats up very rapidly and portions of it undergo rapid changes in temperatures, the temperatures in various parts become uneven, causing thermal stresses, distortion, or buckling. Some form of failure may occur—just as a cold milk bottle cracks when hot water is suddenly poured into it—or the airplane may suddenly develop flutter and be destroyed.

"Horses" That Weigh a Pound Apiece

The greatest single factor in the large gains in aircraft performance has been the development of aircraft engines of large power, low weight, and good fuel economy. The Wrights' first engine was a 4-cylinder, water-cooled piston engine of their own construction which gave about 12 horsepower. It weighed about 15 pounds per horsepower. Today's piston engines deliver 3,500 horsepower with a weight of about one pound per horsepower.

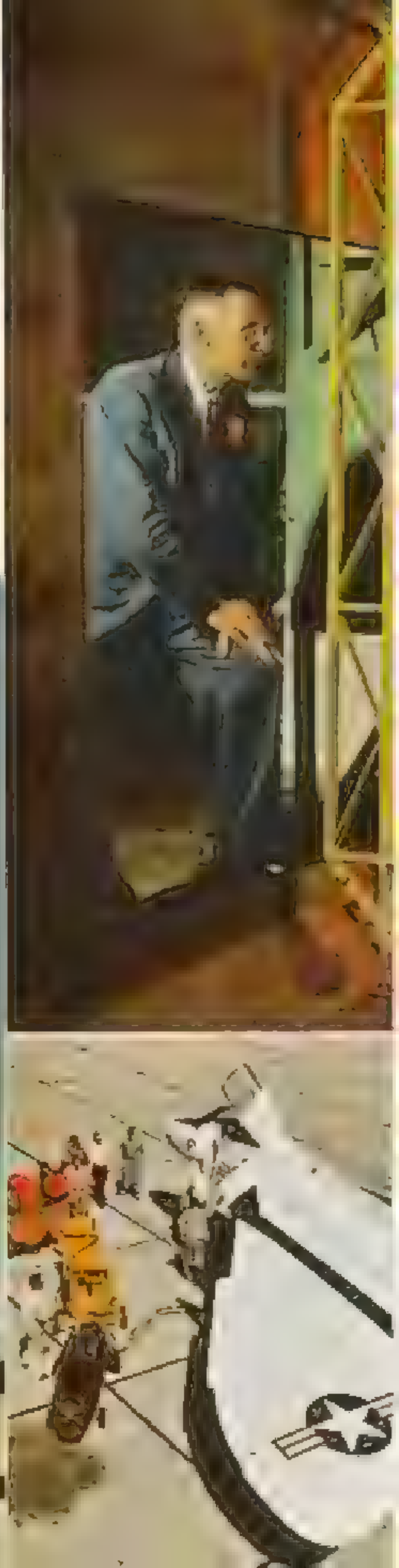
The success of the Wright Whirlwind and the Pratt & Whitney Wasp radial air-cooled engines in the mid-twenties led to their wide and rapid adoption. Lindbergh's *Spirit of St. Louis* was powered by the Wright Whirlwind. The present Cyclone, descended from the Whirlwind, has 18 cylinders in two banks, and the present Wasp Major has 28 cylinders in four banks.

Underlying the development of these remarkably compact and light engines, so indispensable to modern aircraft performance, are many feats of basic and applied research. For instance, the increase in compression ratio of engines and the development of special fuels which do not knock at the higher compression ratios make a fascinating story of cooperative accomplishment by the engine industry, the oil industry, and government. Automobile drivers benefit by this great effort.

Near the end of World War II the propulsion picture was revolutionized by the introduction of the turbojet engine. Like most developments, this one had its seeds in the past. A gas turbine appears in an English patent of 1791, and René Lorin, a Frenchman, proposed in 1908 that the exhaust of a piston engine be discharged through a nozzle for

Sherry Adams: Fish's Clean Lines to Air

[illegible]



NAVY

jet propulsion rather than to drive a propeller.

But realization of the ideas of these optimists had to await advances in other fields, particularly the development of efficient light weight air compressors and high-temperature-resistant materials for turbine blades and combustion chambers.

My first contact with this field was the result of a request from McCook Field to the Bureau of Standards about 1921 for a study of the practicability of jet propulsion. The study was made by Edgar Buckingham, and he concluded quite correctly that at 250 miles per hour the fuel consumption of the most efficient jet engine would be at least four times as great as that of a piston engine driving a propeller. I participated in the discussion of the draft of the report.

My next contact was in 1941 as representative of the Bureau of Standards on the NACA Special Committee on Jet Propulsion under the chairmanship of Prof. W. F. Durand. This committee stimulated the military services to contract with manufacturers of steam turbines for the development of a turbine-driven ducted fan, a small turbojet, and a turbine driving a propeller.

However, the Germans and the British had advanced more rapidly. The Germans had flown a Heinkel-178 airplane powered by a turbojet engine on August 27, 1939, and on May 14, 1941, the British had flown a Gloster airplane powered by the engine invented by that gifted Englishman, Frank (now Sir Frank) Whittle. Not until October 2, 1942, did a U. S. airplane fly with jet power, a copy of the Whittle engine. Not until January 21, 1944, did one of the original U. S. [illegible] fly as a booster engine, and on January 1, 1945, as sole power.

Whittle's earliest patent was filed on January 16, 1930. When he submitted his engine to the government authorities in Great Britain, it was rejected as inoperative. I have heard Whittle state since that they were probably correct in their judgment at the time, but he himself did not give up.

The first German flight used an engine developed from patents of Hans von Ohain, who was totally unaware of Whittle's work.

Jet Engine Would Heat 6,500 Houses

A jet engine is fundamentally a device for converting fuel into heat and then developing thrust from that heat by squirting a jet of hot air to the rear. Any boy who has blown up a toy balloon and let it escape from his hands has observed jet propulsion in action. At low speeds the jet engine is not very efficient; the higher the speed, the more efficient it becomes.

A recent turbojet engine, the Allison J-71-A-1, weighs 3,650 pounds and gives a thrust of nearly 10,000 pounds. The heat generated is enough to heat 6,500 six-room houses in the climate of Washington, D. C. At 375 miles per hour, 10,000 pounds of thrust is equivalent to 10,000 horsepower; at 750 miles per hour, the same amount of thrust is equivalent to 20,000 horsepower.

One of the first discoveries about jet engines in flight was that when the airplane reached a high altitude the "fire" in the engine often went out, or flamed out, as the pilot would say. Unless he could restart his engine at a lower altitude, he had to make a forced landing.

Fortunately, at about the same time this problem was faced, the NACA's Lewis Flight Propulsion Laboratory at Cleveland had completed new research facilities which permitted duplicating on the ground the altitude operating conditions. The NACA collaborated with industry and the military services in the solution of this problem, with the result that jet engines can be operated dependably at altitudes more than twice as high as before this research program began.

Cermets—Metals Plus Ceramics

The jet engine is dependent on advances in physics, chemistry, metallurgy, and their applications, for combustion occurs in air flowing at superhurricane speed and intense heat. To be even reasonably efficient, the jet engine needs to operate at temperatures approaching 1,500° F., and for the future we should like to go to still higher temperatures, perhaps to 3,000° F.

To cope with such terrific heat, new materials combining metals with ceramics, called ceramels or cermets, are under study, and methods of cooling the hot parts of the engine are being developed.

For supersonic propulsion with turbojet engines, it is at present necessary to augment the thrust of the turbojet by the use of afterburning, the burning of fuel in the tail pipe downstream of the turbine blades. There is enough unused oxygen in the jet flow to feed an afterburner because the combustion products in a turbojet must be greatly diluted with excess air to prevent destruction of the turbine blades. We may expect afterburning to become less and less necessary as effective means are devised for cooling the turbine blades or improved high-temperature materials become available.

Other types of power for superspeed include the rocket motor, with which sustained horizontal supersonic flight of a piloted airplane was first attained by the Bell X-1.

Another source of tremendous power and speed is the ram-jet engine, which depends on the high speed of the aircraft or missile

Spearfish of the Sky Is Nordic-powered X-5

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

to ram air at increased pressure into the combustion chamber. It needs no compressor or turbine, but must be moving at high speed before it will go into action.

There is, of course, much speculation about the possible application of nuclear power to aircraft. In principle, the nuclear-fission process can be used as a substitute for the combustor in any type of power plant. But there are many difficult engineering problems, including that of shielding personnel from dangerous radiation. Shield weights are very great. Basic research on atomic power continues, and a nuclear-powered submarine will soon give us invaluable practical experience with nuclear power.*

Atomic-powered Plane Must Be Huge

Sir Harry Garner has estimated the weight of a nuclear-powered aircraft to be something like 500,000 pounds (71 tons heavier than the enormous B-36 bomber) and says he will be surprised if a successful airplane of this kind is achieved within the next 15 years.

So far I have attempted to give an impression of the vast foundation of scientific and technical activity in areas with which I have some direct connection. Advances in other areas are equally necessary, but I can hardly do more than list a few of them.

Modern aviation is greatly dependent on electronic devices. The oldest "black boxes" contained the radio transmitters and receivers. Now radio beacons and blind-landing systems, radar, navigation aids, recognition devices, bombsights, gun sights, and range computers greatly increase the utility of aircraft.

A growing new field is that of automatic pilots and servomechanisms which relieve the pilot from fatiguing tasks, supplement his strength, and react more rapidly to atmospheric gusts.

The acoustical experts have been called upon to soundproof airplane cabins and muffle engine exhausts, but the noisy turbojet has presented a new and difficult challenge. It is not too much to say that a large part of the future of jet transports and of present metropolitan airports depends on the success or failure of the experts' work in alleviating the thunder of low-flying or taxiing aircraft.

Faster and more detailed weather forecasting seems sure to come with new knowledge and use of high-speed electronic computers.

Of great importance is the science of aeromedicine. Military aviation particularly poses problems of enabling men to withstand violent "G" (gravity) forces, rapid changes in altitude (page 780), radiation, high and low temperatures, vibration, and noise. As aeromedicine and engineering work out solutions, civil aviation benefits too—for example in pressurized cabins, oxygen equipment, heating, ventilating, and air-conditioning equipment.

In the preface to his book, *Frontiers of Flight*, George W. Gray points out: "Airplanes today fly faster than the craft of ten years ago, they fly higher and farther, carry heavier loads, are more controllable, and embody greater safeguards against the hazards of take-off, flight, and landing, because we know more aeronautics today than we knew ten years ago.

"And we know more aeronautics because a little group of fact-seeking men have devoted themselves to its study. The entire roster of aeronautical scientists and engineers in the United States is only a few thousand. They constitute an almost microscopic fraction of the population. And yet it is on this small group that progress toward conquest of the air depends." †

I would add to the group of a few thousand some thousands more, all laboring to extend the foundations, to pile stone on stone, to produce an unending sequence of better and better airplanes.

A Glimpse into the Future

Achievements up to now have stimulated the thoughts of men of vision to much more radical developments, beginning with transport of passengers and freight long distances at speeds of several thousand miles per hour.

From this it is but a step to consider vehicles which will become man-made satellites of the earth. A slight additional outreach of the mind suggests interplanetary travel, or, if that seems too great a step, at least travel through space as far as the moon.

I am reasonably sure that travel to the moon will not occur during my lifetime, but I am sure that the technical problems are solvable with a large but finite amount of manpower and money. The missing element today is a still broader experience in the pertinent sciences and technology. Experiment and more experiment, unanticipated scientific developments in apparently unrelated fields, and probably the loss of many human lives in hazardous pioneer flights will be requisite to attainment of this goal.

Kitty Hawk was the climax of the long period in which the dream of human flight stimulated the creative effort of inventors and scientists alike. Today, on the Golden Anniversary of Kitty Hawk, men are still dreaming dreams, stirred by longings for still greater accomplishment, this time to travel beyond the domain of the birds as far as the eye can see.

* See "Our Navy's Long Submarine Arm," by Allan C. Fisher, Jr., NATIONAL GEOGRAPHIC MAGAZINE, November, 1952.

† Quoted by permission of the publisher, Alfred A. Knopf, Inc., New York, 1948.

U.S. ARMY
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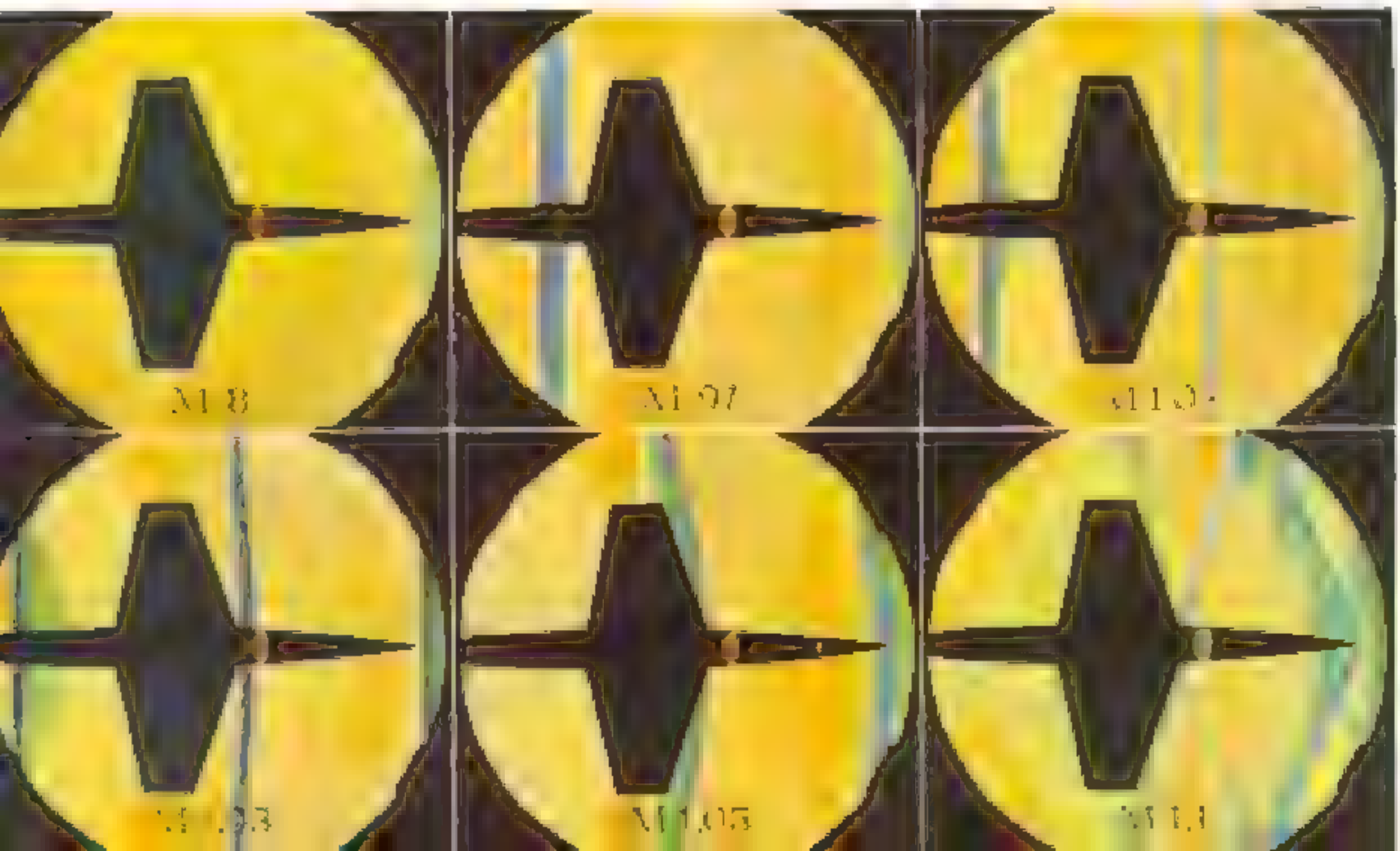
Manned Supersonic Rocket Plane Swept-wing Model

[illegible]

A Swept-wing Airplane Model Breaks Through the Sound Barrier

[illegible]



High-speed Aircraft, in Wind Tunnels and Out, Flap Their Wings Like Birds

B-52 Stratofortresses, Vaulting Mount Rainier, Spearhead U. S. Airpower

Latest development of Boeing's long line of bombers, this 8-jet airplane has entered production; eventually it will replace the B-36 as the Strategic Air Command's intercontinental bomber.

These B-52's resemble the medium B-47 in the 35-degree swept-back wings and pod-mounted jet engines, but the 350,000-pound bomber has a 185-foot wingspan. The Air Force ordered the B-52 into production before the [illegible] and Development Command [illegible].

Performance details are secret. The Air Force says only that the B-52 flies "very high" at "very high speed." This may mean speeds above 600 mph and altitudes above 50,000 feet.

Both B-52 and B-47 use air-to-air refueling to boost range. Flying tankers lower hollow booms as bombers nuzzle up to drink enormous draughts of jet fuel.

The weight of fuselage, [illegible] and engines [illegible] than wings to curve upward in flight and beat up and down in turbulent air. [illegible] wings act as shock absorbers, smoothing out the ride (page 775).

Today's jet bombers operate from heights and under conditions of peril scarcely dreamed of in World War II. [illegible] B-47, the Stratofortress can fly a tremendous distance and drop its bomb load without once seeing the ground. Both bombers need long runways for take-off and landing. A ribbon parachute popped from the tail shortens the landing run.

Gen. Curtis E. LeMay's Strategic Air Command, which will operate the Stratofortresses, holds an unequaled safety record. This year, in 1952, General LeMay received on behalf of his command the [illegible] Award, a silver trophy awarded [illegible] in military flying. The service arm with the best safety record for 100,000 hours [illegible].

Fire and Water Attend the Birth of a New Sea Force

[illegible]

[illegible]

Airmen Briefly Achieve the Weightlessness of Space Flight

While in free fall men may forget gravity. Such falls last only a few seconds at a parachute's speed. [illegible] miles at an average speed of [illegible]

Slow motion film showing professional jumpers are as graceful as artists. Some go down with a swimming motion; some "walk" down, working arms and legs; others drop with marvelous rigidity (top).

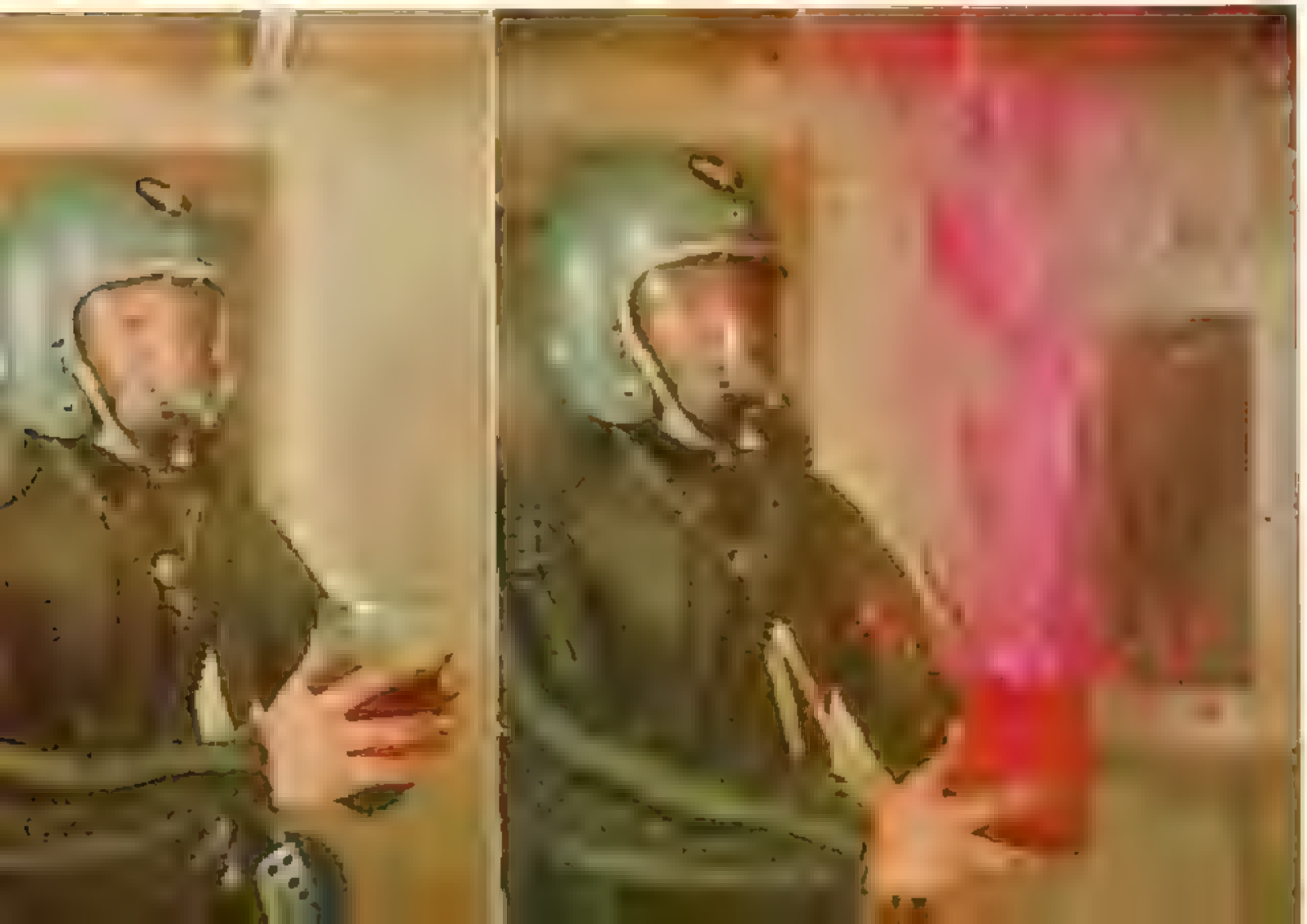
These amateurs jump from an Department of Defense [illegible] parachute [illegible] normal. Some jumpers have "hit the ground" more than 400 times. A few, as land lightly on their feet, usually spill, or roll, wrap up the canopy, and walk away.

Jumpers leaving a Navy R4D transport wear [illegible] that resemble [illegible]

[illegible] against snow, identify parachutes for [illegible]

[illegible] taste more than mass-carrying parachutes. Six-canopy chutes [illegible] carrying a reliance heavier than [illegible] Cargo-dropping parachutes carry loads from a few pounds to many [illegible] requires four parachutes, each 64 feet wide. [illegible] Air Force has tested 15 models of [illegible] first proposed by Leonardo da Vinci, several [illegible] more than four centuries ago.

• Navy's First Operational Swept-wing Fighter, Grumman Cougar, Now Flies from Carriers



Illinois—Healthy Heart of the Nation

An American Miracle in the Prairie State, Industrial and Farming; Titan Rich in Coal, Oil—and Mighty Chicago

By Leo A. Borah

[illegible]

Photographs from Nancy [illegible] Photographer, by J. Baylor Roberts and H. R. Cooper

ILLINOIS owes much of its early development and the phenomenal growth of its great city, Chicago, to geography.

Lying between the Great Lakes and the Mississippi River, the State from the beginning of its settlement was the crossroads of America. Emigrants from Dixieland found homes in its southern part. New Englanders and Scandinavians flocked to its northern portion, and Chicago received all races.

It is impossible to describe a typical Illinoisan, for in the population all America [illegible]

Diversity Amid Flatness

Although Illinois is one of the flattest and least varied of all the States in topography, it shows marvelous diversity in other respects. This middle-western empire of 9,000,000 people ranks fourth in the Nation in farm production, fourth in manufacturing, first in railroad mileage, third in banking assets, and second in wholesale trade, although only twenty-third among the 48 States in size. (See the National Geographic Society's new map, "The Great Lakes Region of the United States and Canada," a supplement to this issue.)

Coal underlies two-thirds of its fertile acres, and reservoirs of oil, tapped by pumps, many of them working away in the middle of cornfields, yield about 60,000,000 barrels annually. From southern Illinois comes more than half of the Nation's domestic shipments of fluorspar, a mineral used in the production of metals, ceramics, and fluorine compounds.

The Prairie State is primarily [illegible] and yet three-fourths of its population is urban. More than half of its citizens live in the metropolitan area of Chicago.

In 1830 Chicago was a frontier village of 50 people. The 1950 Federal census recorded 3,620,962 within its city limits—5,495,364 in its metropolitan area. In eight of the decades since its incorporation as a city in 1837 it has achieved increases exceeding 100,000; in five, gains of more than half a million (page 785).

Without attempting even to enumerate, much less describe, the myriad wonders of the mighty midland metropolis, I merely sketch some of its high lights.

Chicago sprawls over 212 square miles, bordering Lake Michigan for nearly 30 miles. Along the sparkling lake stretches a verdant fringe of beautifully kept parks, sites of notable public show places. On summer days hundreds of thousands of bathers disport themselves on the 22 miles of beaches.

Yachtsmen find breezy Lake Michigan as sporty as salt water. One summer when my family and I dropped in for luncheon at a lakeside restaurant, we watched the finish of a Star-class race in which a hundred trim little sloops competed. Larger craft skimmed along farther out or lay at moorings along the shore.

In Lincoln Park stand the Chicago Historical Society, the Academy of Sciences, a superb conservatory, and a famous zoo that displays its animals on a television show. Jackson Park has the Museum of Science and Industry, where many of the displays are operated by push-button control (page 792).

Near Jackson Park the University of Chicago lifts its graceful Gothic buildings in an attractive setting. The Oriental Institute, repository of priceless archeological treasures, lures throngs of visitors (page 785).

The Art Institute of Chicago and the exquisite Buckingham Fountain (page 782) grace Grant Park on the downtown lake front.

Overlooking the lake are Soldier Field, which seats 100,000; the Adler Planetarium, where stars and planets move realistically in a man-made sky; the Shedd Aquarium, with 10,000 specimens of fishes; and the Chicago Natural History Museum, in which dramatic exhibits tell the story of mankind.

Chicago Proud of Its "Front Yard"

Justifiably Chicago feels pride in its "front yard." I stood for a long time enchanted near the Adler Planetarium, looking across the harbor to skyscrapers against the sky line.

Much of the parkland has been reclaimed from swamps. A little distance offshore, connected by a man-made causeway, is one of three municipal airports.

South of the parks the water front bristles with smoke- and flame-belching steel mills, factories, and furnaces.

Six strange-looking structures thrusting up well out in the lake are "cribs" that serve as intakes for the city's drinking water. Lake water entering these flows through 65 miles of enormous underground tunnels to 12 land

Buckingham Fountain Graces Chicago's Front Yard on Filled Land Near the Lake. Colored Lights Mase It a Fairy Palace by Night

stations which pump it into the water mains.

Until 1900 the Chicago River emptied into Lake Michigan, polluting the water with sewage. Typhoid fever caused hundreds of deaths.

The city solved the problem by making the offending river run backward. To reverse the flow, engineers dug the south branch of the stream deeper than its mouth and connected that branch by a still deeper canal with the Des Plaines River, forming the Illinois Waterway to the Mississippi (see inset on supplement map).

Although Chicago is an inland city, it handles more water-borne traffic than the Panama Canal. Dutch, Swedish, and Norwegian steamship lines connect the city with European and North African ports during the season of navigation on the Great Lakes (page 794). Barges ply from here to New Orleans and other river cities. Annually lake and river cargo totals 46,000,000 tons.

A movement is now afoot to widen the Calumet Sag Channel and thus quadruple the barge traffic through that waterway. In 1848 the old Illinois and Michigan Canal gave Chicago its start in water shipping (page 802). If the Calumet Sag project goes through, cheap river transportation may launch another boom.

Hub of Rail, Highway, and Air Traffic

Truly, geography has built Chicago. Railroads, starting here with the old Galena and Chicago Union line in 1848, have made the city the busiest rail center in the world. Today it is served by 20 major lines operating almost half the total mileage in the country. It handles more freight traffic than New York and St. Louis combined, and its passenger train arrivals and departures, including suburban services, average 1,770 a day.

As in pioneer times, roads converge at Chicago. Illinois has one of the finest and most extensive systems of paved highways ever constructed. Some 500 big trucking companies, besides hundreds of lesser truck fleets, operate in and out of Chicago.

Following the pattern of roads, waterways, and railroads has come air traffic. Eleven major airlines, three feeder passenger lines, three air freight and express lines, besides numerous nonscheduled carriers, serve the city.

At Midway, busiest airport in the United States, 1,000 scheduled airline planes land or take off daily. Passenger arrivals and departures in 1953 totaled nearly 10,000,000.

Inland from the sumptuous water front Chicago has unsightly districts which have become more dilapidated and disreputable through the years. Many of these slums have been cleared, and others are in the clean up process.

In objectionable neighborhoods the city condemns the land, moves residents to municipal or Federal housing projects outside crowded areas, and razes ramshackle buildings. The property thus cleared at public expense is sold cheap to private investors who build on it approved industrial plants or apartment groups. Taxes on the improved property reimburse the city for the cost of slum clearance.

I rode through one South Side district, not far from the University of Chicago, where an insurance company was replacing miserable hovels with handsome apartment houses surrounded by lawns and trees.

To cope with the downtown parking problem, the city is building a huge garage beneath a long stretch of Michigan Avenue.

Out of Slums, a Great Medical Center

A striking example of splendor replacing squalor is the West Side Medical Center going up in an area of tenements and junk yards. It already represents an outlay of $157,000,000. Completed, it will cost twice that amount.

It is one of the greatest concentrations of medical and related institutions anywhere. Within its borders are the University of Illinois College of Medicine, Loyola University's Stritch School of Medicine, the Cook County Graduate School of Medicine, and Chicago Medical School. In addition, the University of Illinois conducts a College of Dentistry and a College of Pharmacy, and Loyola a dental school. There are five hospitals, two schools of nursing, and a tuberculosis sanitarium.

Research, which goes on constantly, has performed miracles. Among the most striking is the research done on the use and application of the B. C. G. (bacillus of Calmette and Guerin) vaccine for tuberculosis.

In a concrete-and-lead-walled basement room the 24,000,000-volt betatron invented at the University of Illinois is being used to treat inoperable cancer by the concentration of penetrating X rays of high energy upon diseased areas.

Chicago claims an imposing list of "greatests" and "firsts," leading all other cities in the Nation in output of meat and packinghouse by-products,* telephone equipment, radios and television sets, railroad equipment, and a score of other products (p. 797). It fashioned America's first steel-frame skyscraper, its first Pullman car, its first real refrigerator car, its first third-rail system for electric railways, and its first successful reaping machine.

At the University of Chicago the first atomic chain reaction, precursor of the atomic bomb, was produced in 1942.

World's largest market for grain futures is

* See "America's 'Meat on the Hoof'," by William H. Nichols, National Geographic Magazine, January, 1952.

Chicago's Skyscrapers Tower Above the Site of Old Fort Dearborn's Log Stockade

[illegible]

Recruits at U. S. Naval Training Center, Great Lakes, Learn to Fight Off Enemy Aircraft

Across Lake Michigan is [illegible] Naval [illegible]

the Chicago Board of Trade (page 791), and largest market for futures on [illegible] onions, the Chicago Mercantile Exchange.

With 3,000 [illegible] largest grain [illegible] for more than [illegible] years—thus [illegible] Hilton [illegible] the [illegible] world's largest hotel.

Merchandise Mart Is Buying Center

The Merchandise Mart, on the bank of the Chicago River just north of the Loop-Town Business district, is the country's largest commercial building. With 93 acres of floor space [illegible] daily working population of [illegible] Marshall Field and Company built [illegible] and sold it in [illegible] Kennedy, foreign banker and [illegible] Middlemasses to Great [illegible].

[illegible] a big department store [illegible] the Mart and [illegible] of goods of all sorts from the [illegible] display. The [illegible] radio force, [illegible] restaurants [illegible].

[illegible] the stores, haul heavy supplies to office [illegible]

[illegible] Harry J. [illegible] through the R. R. Donnelley & Sons Company's printing [illegible] which has an enormous volume of [illegible] size [illegible] Washington, D. C. The [illegible]

[illegible] high speed [illegible] one call to the [illegible] wide variety of magazines and other publications.

Telephone Directories for 500 Cities

[illegible] telephone directories for [illegible] cities and towns and villages. [illegible] The covers printed in the [illegible] for the [illegible] which

[illegible]

[illegible] Sears Roebuck and Montgomery Ward [illegible]

[illegible] Mr. [illegible] Oriental [illegible] American [illegible]

[illegible] Art Institute [illegible] Michigan Avenue [illegible] the most exciting [illegible]

Sedate Evanston Offers Contrast

[illegible] Evanston [illegible] Northwestern University [illegible]

Northwestern University, chartered in 1851, [illegible] New England village in the Midwest.

Colossal Stone Bull Guarded Ancient Persia's Throne Room

[illegible]

Visitors Leaving the Chicago Natural History Museum Face Grant Park and the Michigan Avenue Sky Line

[illegible]

Workmen Adjust the Radio-frequency System on the 450-ton Ring-shaft Cyclotron at University of Chicago

[illegible]

Great Park Band Shell Attracts Crowds to Outdoor Concerts

[illegible]

A Table of Boxing Grips the Great Pit

[illegible]

"Where Is Your Heart"

Today Northwestern University has 13 schools and colleges on its Evanston and Chicago campuses.

Now that the University of Chicago has withdrawn from active participation in major intercollegiate athletics, Northwestern is the only Chicago area member of the Western Conference. Dyche Stadium, seating 54,000 spectators, is the scene of thrilling "Big Ten" football games and other major athletic events.

From 1857 until her death in 1898, Frances Elizabeth Willard, president of the Woman's Christian Temperance Union, made her home in Evanston. Rest Cottage, the modest home given her by the W. C. T. U., is preserved as a memorial and is not only open for inspection but has a library in connection with it.

Despite rather narrow, tree-lined streets, Evanston has won awards repeatedly as the safest place for motor traffic in the United States. The Traffic Institute established at Northwestern University in 1936 trains traffic policemen from all parts of the Nation and many foreign countries.

At Wilmette on the lake shore a few miles north of Evanston is the Bahai House of Worship, the white-domed temple of a faith founded in Persia a century ago by a religious leader, Bahaullah. Bahai temple is dedicated to the unity of all peoples and religions, universal education and language, and world peace.

Naval Training Far from the Ocean

To the north are Fort Sheridan, Army reception and separation center, and the U. S. Naval Training Center, Great Lakes, Illinois.

At Fort Sheridan more than 100,000 inductees have been processed since the beginning of the Korean conflict, and 500,000 men of World War II were discharged.

Between Pearl Harbor and V-J Day nearly 1,000,000 men received their basic training for Navy duty at Great Lakes (page 786). In October, 1948, a Wave recruit school was opened, then the only one in the Navy. It was moved later to Bainbridge, Maryland.

Factory chimneys dominate the sky line in North Chicago and Waukegan, though the latter is still the harbor for a fresh-water fishing fleet and has a big fisheries business. In the two cities there are 65 industrial plants. Waukegan was the birthplace of Benjamin Kubelsky, known to the entertainment world as Jack Benny. Surrounding this city is an area of pastoral beauty, dotted with dairy farms, pretty little lakes, and summer resorts.

Near the northeast corner of Illinois is Zion, religious community started by John Alexander Dowie, who believed the world to be flat even after he had made a trip around it.

On a sunny but chilly morning in late April, Louis Weber, reclamation engineer for the Illinois Coal Strippers Association, and I drove out of Chicago to start a tour that was to traverse 1,800 miles over Illinois from the Wisconsin border, in the latitude of Boston, Massachusetts, to the southern tip, parallel with Norfolk, Virginia.

On our right as we threaded the traffic out of Chicago was Oak Park, once called Saints' Rest because of its many churches. This residential community with a population of 63,529 is the largest village in America; six trustees direct all municipal affairs.

Aurora Started as Two Towns

In the opening words of the State song, "By thy rivers gently flowing, Illinois," lies a fundamental theme of the Illinois story, for it was rivers, providing sites for mill dams, that attracted the early settlers. Most of the older cities and towns are located on the 200 rivers and streams in the State.

On both sides of the Fox River, about an hour's drive from Chicago, is Aurora, a farm town which has gone in for manufacturing in a big way. It started out as McCarty's Mills in 1834 when Joseph McCarty and his brother Samuel selected it as a site for a dam and a sawmill. Joseph McCarty had looked over Chicago but rejected it as "more promising for raising bullfrogs than humans."

Split by the river, Aurora grew up as two rival towns. The public buildings stand on neutral ground, the 10-acre Stolp Island in midstream. On the island stands the 21-story Leland Hotel, highest building in the State outside Chicago.

Aurora boasts that it makes everything from razor blades to road graders.

Near by is Mooseheart, the child city, owned and operated by the Loyal Order of Moose for the care and education of deceased members' children. Thousands of children have been educated here since the magnificent project was started 40 years ago.

In 1854 a group of 208 delegates to a "People's Convention" met in the First Congregational Church of Aurora and founded an anti-slavery party to which they gave the name "Republican." Aurora consequently disputes the claims of Ripon, Wisconsin, and Jackson, Michigan, to the title "Birthplace of the Republican Party."*

Our coast north from Aurora took us through smiling farm country along the Fox River to Elgin, the watch city, which like Aurora began as the site of a mill dam.

Founded in 1835 by James T. Gifford, Elgin

* See, in the NATIONAL GEOGRAPHIC MAGAZINE: "Oh Gives Wisconsin," by Granville Smith, July, 1947, and "Work-hard, Play-hard Michigan," by Andrew H. Brown, March, 1952.

A Swedish Freighter, Entering the Calumet River from Lake Michigan, Passes Docks Loaded with Coal, Grain, and Steel

[illegible] Calumet River, Lake [illegible] Western [illegible] Steel Machine, and Lake Michigan. [illegible] Panama Canal.

Means but No Ends Separate Glucagonns and Polar Bears

[illegible]

prospered early in its history, for it was on the stagecoach road that led from Chicago to the then thriving lead-mining city of Galena. By 1850 the Galena and Chicago Union Railroad had reached Elgin, bringing a temporary boom, but as soon as the line was extended to Rockford passengers, instead of getting off to settle in Elgin, continued to the end of the line.

The situation was saved finally through Gifford's friendship with B. W. Raymond, third mayor of Chicago. When Raymond went into partnership with eastern investors to establish a watch factory in the Middle West, he gave Elgin the business.

That was the beginning of the Elgin National Watch Company. Two years ago it turned out its 50,000,000th watch.

I went along the assembly lines where deft workers were putting watch movements into cases and making adjustments—an extremely delicate procedure. Each day about 5,500 watches are turned out by the factory. Every part of the watch except the jewels is made in Elgin. The jewels come from Switzerland.

Northwest of Elgin we drove through a rather hilly, grove-dotted region of dairy farms. Fine herds of blooded milk cows grazed in green pastures near trim farm buildings. The principal towns are Marengo, home of a large mousetrap factory, and Belvidere, where sewing machines are made.

Rockford Machines Make Machines

Having been in Rockford for a few weeks in the first year of World War I, I expected to see familiar surroundings when we reached this manufacturing city of 105,438 people, third in size in Illinois. I failed to recognize anything about it except the beautiful Rock River and the fine trees that give it the nickname "Forest City."

Camp Grant, thronged with soldiers in my time, is now a municipal airport, and only a scattered few of the old war buildings remain as homes for industrial workers.

In 1917 the principal industries were the manufacture of furniture, knitted goods, and hosiery. Now, in terms of dollar value, the city ranks fifth in the United States as a producer of machine tools, "the machines that make machines." Furniture and hosiery (people of my generation surely remember the old Rockford seamless socks) are still made here, but metal wares have left them in the background.

With 400 factories making some 300 types of products, Rockford boasts that it is the most diversified city in Illinois. Many of the scores of manufacturing plants started as backroom shops of the clever Swedish artisans whose ancestors came to Illinois a century ago.

As we rode alongside the Rock River, I espied several crews of Rockford College girls rowing racing shells. Century-old Rockford College, which claims Jane Addams, a founder of Hull House in Chicago, as an alumna, is a distinguished school for women.

In its long roster of famous people Rockford lists also James Henry Breasted, renowned archeologist and author; Frank La Forge, noted composer, and Martin Johnson, world traveler and lecturer.

The homey old city of Freeport is only 15 miles from the Wisconsin border, in rich farm and dairy country.* At the village of Winslow near here my mother was born. My grandfather heard the Lincoln-Douglas debate in Freeport on August 27, 1858.

When Lincoln asked Douglas whether the people of a territory could lawfully exclude slavery before adopting a State constitution, the "Little Giant" replied emphatically that they could. By uttering this "Freeport heresy," Douglas split the Democratic Party and made possible Lincoln's election in 1860.

A model of prosperous stability, Freeport changes little through the years. It has well-established industries and a brisk trade as seat of one of the richest counties in Illinois.

Although Galena, now shrunk to a population of 4,048, sits dreaming of bygone glory on its rugged terraces above the Galena, formerly the Fever River, time was when it was the metropolis of Illinois and Chicago a mere trading post. The post office was established here in 1826, the first in northern Illinois. For more than half a century before the Revolutionary War lead was mined on the Fever River by the French, and the district figured prominently in the Mississippi Bubble promotion scheme of John Law in 1717.

Lead mining here became unprofitable in the middle of the 1800's. In the panic of 1857 the old town suffered seriously.

Grant Went Out from Galena in Glory

From Galena Ulysses S. Grant went out to duty as a colonel in the Civil War. He had been employed there in his father's leather shop. To Galena he returned in 1865, the conquering general, and received from the townfolk the mansion which still stands as he loved in it, a State-kept memorial.

[illegible] of Galena, almost [illegible] Wisconsin border, is 1,241-foot Charles Mound, highest point in Illinois.

Birds were just beginning to open on the trees when Mr. Weber and I left Galena and headed south along the Mississippi River. As

(Text continued on page 805)

* See "Deep in the Heart of Swedendom," by William H. Nicholas, NATIONAL GEOGRAPHIC MAGAZINE, June, 1934.

Zenith TV Sets Speed Down the Production Line

[illegible]

[illegible]

Dressmaking Replaces Mining in Hazard

[illegible]

Decatur Workers Take a Break on the Roof Garden of A. E. Staley Manufacturing Company, Processor of Corn and Soybeans. Insert: [illegible]

600 Tractor Wheels Roll Daily from International Harvester's Rock Island Stockpile

[illegible]

Old Good Rocks Work No Longer at Glamination

[illegible]

Belgian Horses Parade in the $2,000,000 Livestock Exhibit at the State Fair in Springfield

[illegible]

Field Hands Near Mexico Harvest Helped Bananas

Paris, Illinois, Workers Make the Canned Product—Grocers

we rolled downstate, we plunged into the tide of advancing spring. Trees were in nearly full leaf at Chicago on our arrival there a week later. In southern Illinois spring comes nearly a month earlier than in the north.

Our road led us past Mississippi Palisades State Park, one of the finest of the 35 in Illinois, a rugged bit of unspoiled wilderness on high bluffs a few miles north of Savanna.

We found Moline and Rock Island humming with industry as usual. These towns, East Moline, and Davenport, just across the Mississippi in Iowa, are the "Quad Cities," the farm machinery capital of the world (page 800).

The Quad Cities have six plants of Deere & Company, two manufacturing branches of International Harvester Company, Minneapolis-Moline Implement Company, J. I. Case Company, and many smaller concerns manufacturing agricultural implements.

In 1837, John Deere, a hard-working blacksmith, developed at Grand Detour, Illinois, a steel plow that would successfully "scour" in the sticky Illinois soil.

After a successful start in Grand Detour, Deere moved to the "nice little village" of Moline to take advantage of water power and cheap transportation. He manufactured 700 plows here in his first year.

Plow and Reaper Made Farmers Rich

By 1848 Cyrus Hall McCormick was manufacturing reapers in Chicago. The plow and the reaper launched Illinois on the way to farm wealth.

On a 1,000-acre limestone island in the Mississippi River across a moat from Rock Island and Moline is Rock Island Government Arsenal, making war equipment from ammunition belt links to 50,000-pound gun carriages.

With a population predominantly Swedish and Belgian, Rock Island and Moline retain only faint memories of the Sac and Fox Indians who once dwelt along the Mississippi bluffs. A 207-acre State park near Rock Island is named for the falcon-eyed chieftain Black Hawk, whose braves were defeated in 1832 in the war in which Lincoln, a militia captain, said he had "many bloody struggles with mosquitoes."

From Rock Island my companion and I drove southeast across lush farmlands to Galesburg, at once a farmers' town and a railroad and manufacturing city. It is amazing how quickly industrial scenes give way to smokeless agricultural country in Illinois.

At Galesburg is Knox College, the "Old Swash" of alumnus George Ade's famous magazine stories of Ole, the Viking fullback who sulked and refused to play until he was initiated into several fraternities. Poet Edgar Lee Masters attended Knox long enough to flunk his Latin. Don Marquis called the school his "step college," and to Eugene Field it was "one of my numerous alma maters."

Although Carl Sandburg, distinguished poet and biographer of Lincoln, is not a Knox graduate, he took his degree at Lombard College, which later was absorbed by Knox. The house where Sandburg was born is now maintained as a show place.

Galesburg owes its beginning to Knox College, for the Reverend George Washington Gale brought the original 200 settlers here in 1836-37 to set up a Christian college on the western prairie. Beside "Old Main," still standing on the campus, Lincoln and Douglas held the fifth debate of their series.

Strip Miners Restore Land

Between Galesburg and Peoria Mr. Weber took me over a strip coal mining operation. We crossed miles of "spoils," wastes of earth and rock ridges flung up by the scoops of the strippers as they cleared the overburden from beds of coal. Here and there pieces of "place" land had been left undisturbed, parts of farms still under cultivation.

"The companies buy up all of a farm, even though part of it does not contain coal or is untillable; this untilled portion is kept in cultivation," Mr. Weber explained. "Farming continues until stripping begins.

"We don't blame people for complaining about the unsightliness strip mining causes, and our job is to do something about this problem. We have planted 12,000,000 trees on thousands of acres like this.

"In years of intensive cultivation rainfall has leached down mineral nutrients from the surface until the soil will not grow crops without the addition of limestone and phosphates. Stripping brings up the mineral nutrients, and what we try to do is to grow homes and children.

"The coal under a farm is worth from 300 to 500 years of crops. Still, we don't like to cause wastes."

Mr. Weber drove the car into a long ravine-like pit where a gigantic stripper was scooping a 50-foot overburden from a thick layer of coal. With a bucket that took 40 cubic yards from the bank with each bite, it lifted the overburden and piled it to the side of a clearing about 100 feet wide.

We rose on the exposed coal to within 100 yards of the mighty machine. The scoop looked big enough for a two-car garage.

As soon as this strip is finished, loading shovels dig up the coal and put it into trucks to be hauled to the tipple. The shovels hold 7½ cubic yards, the trucks 38 tons. At the tipple the coal is washed and put aboard railroad cars for shipment to market.

Cairo Thrusts a Wedge into the Junction of the Mississippi (Left) and the Ohio

[illegible]

Towering Levees Have Protected the City from Disastrous Floods for a Century

Here is Monmouth Street [illegible] the gulf. Two miles [illegible] the same place the [illegible] a foot.

The overburden from the next strip is dumped into the empty pit, and this process goes on until the last cut of the job is reached.

"What happens to the last cut?" I asked the superintendent in charge.

"That fills with ground water," was the reply, "and becomes a lake. We have made 2,500 acres of new lakes and stocked more than half of them with fish."

Near Danville a week later we visited another strip-mining district where enormous dragline strippers were employed. Danville, home of Joseph Gurney ("Uncle Joe") Cannon, famous speaker of the U. S. House of Representatives, of which he was a member for 46 years, began as a village around a salt lick. Now it is a brisk manufacturing, farming, and strip-mining center.

In 1952 the strip mines in Illinois produced 17,000,000 tons of coal—slightly more than 37 percent of the State's total coal production. Thus far, 55,000 acres of land have been stripped. The companies have given clubs and communities large tracts for recreational uses.

William Cooke, president of the Illinois Coal Strippers Association and owner of the rich Little Sister mine south of Canton, is a reclamation enthusiast. He has graded 1,500 acres and put it to diversified farming.

Chief among his enterprises is a "pig hatchery" equipped to handle 10,000 pigs a year. His stock is an aristocratic cross between Hampshire hogs and the famous Danish Landrace breed. In a palatial farrowing house the pigs are left with the sows for three weeks, then put on a formula of synthetic milk containing penicillin, aureomycin, and terramycin. When they are eight weeks old, they are turned over to tenant farmers or sold.

Mr. Cooke goes in for everything on a grand scale. Finding that multiflora roses make animal-tight hedges, he planted miles of them.

Progressive Peoria, Industrial Giant

We went alongside the Illinois River northeast to Peoria, second city in Illinois with a population in 1950 of 111,856. One of the oldest settlements in the Mississippi Valley, Peoria, in 1825 was the seat of the county of which Chicago was a tiny precinct.

Situated 130 miles southwest of Chicago on the Illinois River, most important link in the Great Lakes-to-Gulf waterway, Peoria has become an industrial giant.

The Caterpillar Tractor Co. is the largest of its 160 industries. In a similar enterprise Robert G. Le Tourneau, evangelist engineer who says, "God runs my business," started a big factory which he sold recently (page 799).

Perhaps the most famous Peorian of the past was the freethinker, Robert G. Ingersoll. The Most Reverend Fulton J. Sheen, Mr. and Mrs. Jim Jordan (Fibber McGee and Molly), and Charles Correll, the Andy of "Amos 'n' Andy," are present-day celebrities born in Peoria.

Peru and La Salle owe their early growth to the old Illinois and Michigan Canal, for Peru, founded in 1835, became terminus of the waterway completed in 1848. When La Salle built a steamboat basin, however, it took the canal trade away from its sister town. La Salle had its birth in 1827 when plans were started for the old waterway. The two towns were at the head of navigation on the Illinois River.

Peru's principal business wakes up more people than any other concern in America, for its product is alarm clocks—Westclox and Big Ben.

At Ottawa on August 21, 1858, the first Lincoln-Douglas debate attracted a crowd of 10,000, twice the population of the town.

Starved Rock State Park, second oldest State park in the Illinois system, is near Ottawa. With 1,437 acres of bluffs, canyons, and gigantic rocks, it offers rugged natural scenery.

Joliet a Great Wallpaper Center

With seven plants, Joliet has the greatest concentration of wallpaper manufacturing in this country. Here also is the world's largest nail factory and important works of the American Steel & Wire Division, United States Steel Corporation. The city lies on the Great Lakes-to-Gulf waterway, which carried 17,500,000 tons of barge freight through the Des Plaines River in 1952.

Besides its tremendous output of manufactured goods, Joliet produces what it proudly boasts are the best bands in the country. High-school youngsters here have won so many contests that few band musicians from other cities will venture to play against them.

Around Bloomington and its next-door neighbor Normal the rich black soil of the level Illinois prairies produces prodigious crops of soybeans and hybrid seed corn, insuring prosperity for the citizens of the two towns.

Of distinguished literary and national figures Bloomington has produced a proud quota; to mention just a few: Elbert Hubbard; Sidney Smith, creator of Andy Gump; Melville E. Stone, co-founder of the *Chicago Daily News* and first manager of the Associated Press; Adlai E. Stevenson, Vice President of the United States under Grover Cleveland, and his grandson Adlai E. Stevenson, former Governor of Illinois and recent Democratic candidate for the Presidency.

Bloomington claims the oldest Passion play in the United States, a 65-scene performance

Meat Products Make Lost St. Louis a Leading Packing Center

which has been presented annually twice a week in April and May for 31 years.

From religious pageantry to the circus seems a far cry; yet Bloomington has won fame for the trapeze performers who have prepared their acts there. Clyde Noble, retired member of the "Five Flying Fishers," says as many as 200 aerialists have trained in Bloomington at the same time. The tradition started in the 1890's with two farm boys, the Green brothers, who, after seeing a traveling circus, went home and practiced in the haymow till they had an act which later was featured in Barnum's circus.

In Decatur, founded in 1829, Abraham Lincoln came with his father's family as a youth of 21. He and his cousin, John Hanks, split rails for a living here in 1830.

When the Republican State convention met in Decatur on May 9, 1860, Hanks carried in two rails with a Lincoln banner, stampeded the convention, and defeated William H. Seward.

Nowadays Decatur is a railroad and manufacturing center making goods ranging from fly swatters to steel bridges. Its main claim to fame, however, is that it is the leading soybean processing center in America.

Mr. Weber and I visited the magnificent plant of the A. E. Staley Manufacturing Company, maker of soybean and corn products (page 798). It is the largest of five processing concerns in the city, which together can handle 50,000,000 bushels of soybeans a year.

From Decatur we swung south to Pana, a coal-mining town which paradoxically ships out annually to florists all over the country 20,000,000 cut roses. There are 60 acres of roses under glass in five big nurseries.

"How did you happen to start rose culture in a coal town?" I asked a rather taciturn owner of one of the largest nurseries.

"Well," he said, "we had five deep mines in the 1920's (there is no strip mining around Pana) and four railroads, but coal got so cheap we decided to try something else."

Surplus Crops Stored in Field Towers

Beside the road on our way to Springfield I noticed a large group of round towers. I had seen scores of these throughout the journey, often on fields far from market centers.

When I asked a farmer what they were, he said with a grin, "Those are monuments to legislative attempts to repeal the law of supply and demand. They are filled with soybeans, corn, and grain the Government has bought and stored to keep prices up."

Springfield, the State capital, is the heart of Lincoln Land. Though the Great Emancipator was born in Kentucky and grew to manhood in Indiana, he is best known to history as "Abe Lincoln of Illinois."

A two-story frame house, the only home Lincoln ever owned, is kept with some of the original furnishings much as it was when he and Mary Todd Lincoln lived in it. Open to the public, it annually attracts hundreds of thousands of visitors.*

A towering obelisk in Oak Ridge Cemetery dominates the Springfield sky line. There rests the body of the man who "belongs to the ages." The tomb is a national shrine maintained by the State.

Everywhere in the capital city I saw reminders of Lincoln. The Abraham Lincoln Hotel had a picture of Lincoln in every room, and his likeness even on the paper wrappings of the sugar cubes in the restaurant. Going about town, I counted 37 establishments using the word "Lincoln" in the names.

Springfield is a sprightly, prosperous city of 81,628 population, fifth in Illinois. Coal underlies even the capital, and one deep mine was in operation until 1953 (page 815).

The Sangamo Electric Company is a major producer of electric meters and electronic equipment. Making road-grading and earth-moving machinery are Allis-Chalmers Manufacturing Company and the Baker Manufacturing Company.

Youthful Lincoln Worked in New Salem

Before starting out from Springfield for southern Illinois, Mr. Weber and I pursued history to New Salem State Park, the faithful restoration of the village where young Lincoln was by turns laborer, storekeeper, postmaster, surveyor, and legislator. We went on two miles to Petersburg to visit the grave of Ann Rutledge, at whose father's tavern Lincoln lived for a time.

Although legend says Ann was so beloved by Lincoln that her untimely death in 1835 almost ruined his career, scholars have been unable to substantiate the story. Whether or not the tale is true, Edgar Lee Masters' verse engraved on the girl's tombstone is exquisitely poignant.

"Out of me unworthy and unknown
The vibrations of deathless music;
'With malice toward none, with charity for all.'"

Carthage, a few hours' drive northwest of Springfield, still preserves the old jail where Joseph Smith, founder of the Church of Jesus Christ of Latter-day Saints, and his brother Hyrum were shot and killed by a mob June 27, 1844. They were being held awaiting trial on charges of destroying an opposition press in Nauvoo (page 816), a city the Latter-day Saints had built.

On a maple-shaded campus in Carthage is

* See "Vacation Tour Through Lincoln Land," by Ralph Gr[illegible] Magazine, [illegible] 1952.

A Deaf Boy Learns to Speak at Illinois State Normal University

[illegible]

Carthage College, alma mater of my [illegible] friend the late William H. Nicholas, [illegible] editor of the NATIONAL GEOGRAPHIC MAGAZINE at the time of his death [illegible].

[illegible] Quincy, [illegible] city on the Mississippi River. In the middle of the business district is a New England-type town square, Washington Park, where the Mormons rested on their flight from Missouri and where Lincoln and Douglas held their sixth debate on the slavery question.

The heyday of steamboat traffic on the Mississippi [illegible] Quincy [illegible] the Civil War. Now it derives its income [illegible] modern industries, and the [illegible] of the Chicago, Burlington and Quincy Railroad. The famous [illegible] that once crowded its water front [illegible].

A [illegible] Quincy business woman said to [illegible]: "We don't have sudden bursts of [illegible]ment here. Most Quincy industries are [illegible] and long established. Quincy is a city of prosperous contentment."

At Alton we entered one of the most intensely concentrated industrial areas in Illinois. The city, five miles north of the confluence of the Missouri and Mississippi Rivers, has the Owens-Illinois Glass Company, largest glass-container factory in the world, and other big industries [illegible] refineries, [illegible], and scores of smaller plants. [illegible] barges pass constantly [illegible] in the Mississippi, and smoke from hundreds of chimneys lies heavy over the water front.

On [illegible] bluffs [illegible] the factory [illegible], residential Alton is smokeless. I found [illegible] Western Military Academy, where I was a faculty member at the beginning of World War I, not greatly changed.

Lincoln "Fought" Comic Duel Near Alton

Alton was the scene of the final debate between Lincoln and Douglas in 1858. Twenty-one years earlier the Abolitionist editor [illegible] Lovejoy was murdered here while defending his [illegible].

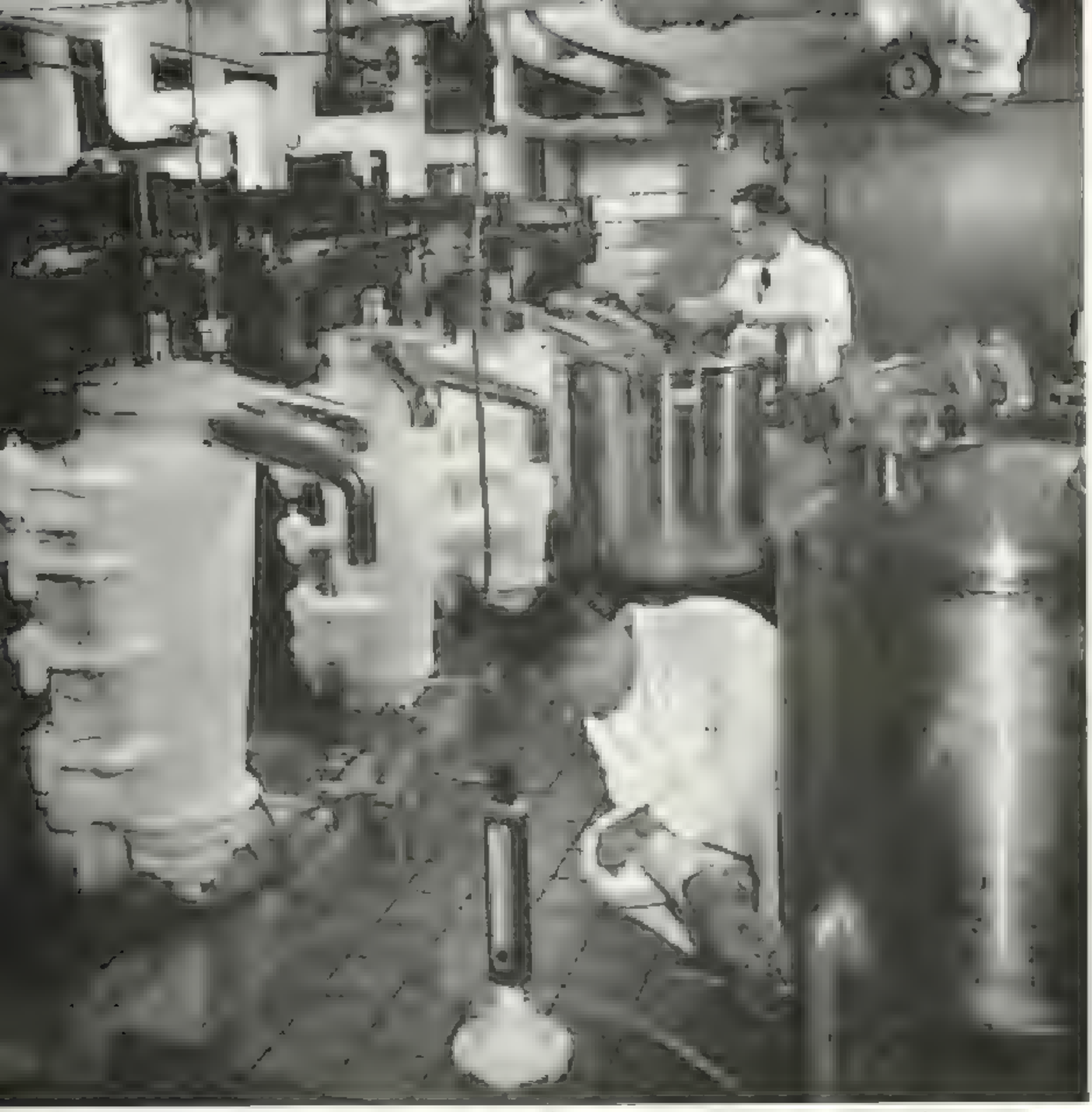
Lincoln and James Shields met three miles from Alton to settle in a duel a dispute about newspaper letters—one written by Lincoln and two others by Mary Todd (or Julia Jayne)—which Shields said had libeled him.

Teacher Muses a Toy Horse from Paper, Paste, Paint, and Scrap Wire

[illegible]

Illinois Students Meet at the Library

[illegible]



[illegible]

Naval Laboratories Photographic Center Processes Blood for Gamma Globulin

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

of the Nile, southern Illinois is called "Egypt." At Cairo (pronounced Care-o in Illinois) on the southernmost tip of the state the Ohio River joins the Mississippi. The two mighty streams [illegible] [illegible] [illegible] [illegible] [illegible].

Two high bridges [illegible] the [illegible] carrying traffic across the Mississippi into Missouri, the other [illegible] the Ohio into Kentucky.

Here [illegible] [illegible] and [illegible] [illegible] thousands of [illegible]. The [illegible] of Cairo [illegible].

In the [illegible] when Cairo [illegible] as a river town, [illegible] 500 river boats were tied up along the Ohio levee at [illegible] [illegible] above the wall [illegible] people in the [illegible] looked up at them.

[illegible] miles up the Ohio [illegible] [illegible] [illegible] the [illegible] West [illegible] [illegible] where the river [illegible] [illegible] [illegible] [illegible] [illegible] west of Paducah, Kentucky.

The [illegible] [illegible] a large [illegible] of the [illegible] in this country [illegible] around Rosiclare. Some of the [illegible] [illegible] mined under the Ohio River.

Now moved back from the [illegible] stream which can be cruelly treacherous is most of old Shawneetown,* [illegible]

* [illegible] "Shawneetown [illegible]" [illegible] Society [illegible] [illegible]

515

Illinois Capitol Lifts Its Dome 361 Feet Above Springfield

[illegible] when [illegible] coal seams beneath the city and its environs [illegible]

Cheese, Wine, Grapes Prosper Nauvoo, the Town That Died Twice

[illegible]

of the old-timers still cling to their homes on the bank.

Oil has brought wealth to Mt. Carmel, where 355 wells have produced 9,336,000 barrels since 1940. Now the yield exceeds 875 barrels a day.

We lodged for a night near Carbondale in a motel on the shore of Crab Orchard Lake, largest artificial lake in southern Illinois. Stocked with bass and bluegills, it affords good fishing.

Carbondale is Southern Illinois University, the second largest State-supported university in the State. It is called "the suitcase college" because most of its 3,000 students live in nearby towns and go home for week ends.

Peaches, apples, and other fruits account for much of the prosperity in Carbondale, although the city is near a coal-mining district.

I talked to R. D. Lane of the Central States Forest Experiment Station, who is initiating a program of research to determine the best way to reforest submarginal lands in southern Illinois. There are large tracts of merchantable hardwood timber in the hill country.

Near Du Quoin is the United Electric Coal Companies' Fidelity mine, largest strip mine in Illinois (page 818). On reclaimed land the United Electric owners have hundreds of acres of bearing peach and apple orchards, also pasture lands. Another large tract of spoils has been converted by the Coca-Cola Company into a picnic park and one of the finest trotting-race tracks on the Grand Circuit.

Over at Herrin deep-mine coal production has declined to the point where new industries must be established to take care of jobless workers. A big dress-manufacturing concern is one of the most important (page 797).

Center of Population Near Olney

We passed scores of oil pumps working steadily in the middle of cultivated fields as we rode to Dundas near Olney to see the monument that marks the center of population of the United States (page 820). Laughing, my companions suggested that we walk a few steps westward from the marker, for he said the center is shifting that way and he wished to be sure he had stood on the exact spot.

Cornfield oil wells were numerous as far north as Effingham. There I was interested in the Petty store, a small-city retail establishment which has won acclaim for its revolutionary cost-saving methods.

"No wonder Charlie Brown, our National Geographic Society chief auditor, is efficient," I remarked. "This is his home town."

Around Mattoon, north of Effingham, fields were being prepared for the planting of broomcorn (page 804), a crop grown in comparatively few areas in the United States.

In late afternoon we came into Champaign-Urbana, twin-cities seat of the great University of Illinois (page 813).

In the words of Lincoln's Gettysburg Address the university, which represents the whole State of Illinois in miniature, may be described as "of the people, by the people, and for the people."

All over the big campus, faculty and students (there are more than 18,000 students in residence and 3,000 faculty members) were engaged not only in academic courses but in research vital to business, agriculture, and public welfare.

Cure for "Tired Tracks"

Railroad officials came to the university scientists years ago with the problem of mysteriously cracking rails. Using an ingenious rolling load machine that in a week subjected a rail to the equivalent of a year's service, Prof. H. F. Moore found the cause of the trouble and proved that controlled cooling, earlier suggested in Canada, would put an end to what is called "rail cancer."

The research cost the railroads $200,000. Already it has saved them millions and insured against train wrecks caused by "tired tracks."

Prof. Joseph T. Tykociner pioneered in photographing sound on a motion picture film. As the result of such experiments, the world now has talking motion pictures.

Prof. Julian R. Fellows, because his wife was annoyed by the smoke and dirt of her soft-coal furnace, developed a downdraft furnace that not only does not smoke but saves coal by consuming more of the gases.

Awe-struck, I watched the "magic brain" of the University of Illinois computer multiplying two 12-digit numbers a thousand times in a second.

The betatron was invented by Prof. Donald W. Kerst. His 340,000,000-volt machine spots atoms and takes pictures through 20 inches of steel.

In the Morrow plots on the agriculture campus, scores of soil-fertility problems have been solved by experiments which have gone on continuously since 1876.

The university planted in its own greenhouses the first soybean seeds ever tested in the Middle West. By a determined campaign Dr. William L. Burlison sold to farmers the idea of growing the crop. Only 15,000 bushels of soybeans were grown in Illinois in 1914. In 1950 the State produced 95,730,000 bushels, worth more than $200,000,000. University chemists have discovered dozens of uses for the beans.

I found veterinarians and other scientists working on experiments that have conquered

Giant Shovels Dig Earth and Coal Near Du Quoin

[illegible]

Oil Field Workers Work Amid Gas

[illegible]

620

Center of the Nation's Population Lies in a Southeastern Illinois Cornfield

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Religion Flourishes in Illinois

[illegible]

[illegible]

New National Geographic Map Presents the Busy, Historic Great Lakes Region

IN the heart of eastern North America lie [illegible] they could easily be seen from the moon with the naked eye. "Seas of Sweet Water" they were called by 17th-century French explorers. Today we know them as the Great Lakes—and perhaps no feature on the earth's old face better deserves the adjective.

Shared by Americans and Canadians, the Great Lakes influence the lives of millions in the most populous areas of the United States and Canada. Affecting climate, bearing ships, yielding fish and recreation, these gifts of ancient glaciers are bounties beyond price.

Now, in a new 10-color map, "The Great Lakes Region of the United States and Canada," the National Geographic Society presents these five fresh-water seas and all or part of 22 States and three Provinces.

More than 2,100,000 copies of this special supplement to the December NATIONAL GEOGRAPHIC MAGAZINE have been printed to meet the needs of The Society's world-wide membership.

Nearly 12,000 Places Shown

On wall or desk—or in the car—the map will serve as an ever-ready guide to one of the easiest, most productive, and most scenic areas of the world. Members will find it useful for reference also in reading the articles on Illinois and Ontario in this issue. It contains more place names—11,959—than any map ever before published by The Society.*

Notes in blue on the Great Lakes point out water links with their neighbors. Four of the notes refer to large-scale insets that hold a magnifying glass to canals, locks, and dredged river channels connecting the sweet seas. Through these passages glides an endless procession of ships hauling iron ore, grain, fuel, automobiles, and other merchandise—an annual tonnage exceeding that of all Uncle Sam's ocean-going merchant fleet. One inset shows how the Illinois Waterway bypasses to the Mississippi part of the Great Lakes' natural drainage to the St. Lawrence.

Many new features—roads and towns, military bases, canals, and dams—appear on this National Geographic map, 42 by 28 inches.

The atomic age is represented by Chalk River, in the Ottawa River valley, site of Canada's nuclear research station, and by two major centers for U. S. study: the Argonne National Laboratory near Chicago, and Brookhaven on Long Island, location of Brookhaven National Laboratory.

Railroads and highways lay a tight mesh of travel routes across the map area. Many of these thoroughfares follow pioneer pathways through the mountains and along the rivers toward the west. Transcontinental highway U. S. 40 roughly coincides with the old National Road that led settlers toward St. Louis.

Nine of the 10 largest cities of the United States (all except Los Angeles) appear within the mapped area. Three of them—Chicago, Detroit, and Cleveland—bathe their feet in the Great Lakes. Five States shown—New York, Pennsylvania, Ohio, Indiana, and Illinois—together have 48,000,000 people, 31 percent of the Nation's population.

Despite the map's emphasis on the tremendous development of man's works in this region, primeval spots remain. Roadless areas preserve wilderness conditions in Ontario's Quetico Provincial Park, in the northwest corner of the map, and in the adjoining U. S. Superior National Forest. In parts of the latter, even airplanes are forbidden.

For 1,290 miles along the Great Lakes and the St. Lawrence River, Canada and the United States meet on a peaceful water boundary. A 48-mile stretch of this border, between Ogdensburg, New York, and Cornwall, Ontario, is the area involved in the proposed St. Lawrence Seaway and Power Project. Its proponents envision canals of 27-foot depth and a giant powerhouse with a hydroelectric output of 2,200,000 horsepower.

How the Great Lakes Got Their Names

Lake Superior, incidentally, is the only one of the five Great Lakes whose name has no Indian associations. French explorers called it *le lac superieur*, meaning "the upper lake." No more apt designation could have been chosen for so majestic a body of water.

Huron tribes and Lake Huron took their names from a French epithet meaning "bristly savage." The name of Lake Michigan came from Algonquian words for "wide waste." Erie, possibly Indian for "long-tailed cat," named a tribe and the shallowest of the Great Lakes. Ontario is from the Iroquoian for "beautiful lake." Other rhythmic Indian names—Mississippi, Keweenaw, Winnebago, Ottawa, Menominee, and many more—stud the map, keeping alive memories of America's first settlers.

* Members may obtain additional copies of the map of the Great Lakes Region of the United States and Canada (and of all standard maps published by The Society) by writing to the National Geographic Society, Washington 6, D. C. Prices in the United States and elsewhere, 50¢ each on paper, $1 on fabric; Index, 25¢. All remittances payable in U. S. funds [illegible]

Ontario, Pivot of Canada's Power

Cities Burgeon, Pastures Spread, Factories, Forests and Mines Give Up Their Wealth in the Great Province

By Andrew H. Brown

National Geographic Magazine Staff

With Photographs by Nat and Constance Farbman, Photographers, H. Lubomir Sarnat and Bates Littlehales

AFTER 4,000 miles of travel through Ontario I felt that I had explored a whole country rather than just one of Canada's ten Provinces.

This was not surprising, for Ontario is larger than France and Spain together. It measures more than 1,000 miles north to south, linking polar bears and peaches. East to west it spans an almost equal distance, sharing the international border from New York State all the way to Minnesota.

The Province, furthermore, comprises a range of geography that many entire nations lack—from unpeopled wilderness to tightly cultivated farmland and teeming cities.

It is the very bigness of Ontario, plus the strength of great resources, that makes mighty this richest, second largest (after Quebec), and most populous Province in the giant country to the north.

Ontario faces the United States across four [illegible] Great Lakes. Rivers of the [illegible] miles long and so wide you can't see across them. Her north-flowing rivers face empty "bush" that would swallow half a dozen of our lesser States.

Though the northern reaches of Ontario are treeless shores battered by Hudson Bay ice floes, Pelee Point on Lake Erie carries the Province to the latitude of northern California; all, or parts, of 25 States lie farther north.

The strength of Ontario lies in its men, money, and machines, all at work boosting the productivity of farms and factories, mines and forests. Her people, a third of Canada's 15 million, produce 50 percent of the nation's manufactured goods, including almost a quarter of its enormous newsprint output.

Ontario has a near-monopoly of nickel. Mines in the vicinity of Sudbury furnish more than 80 percent of the world's supply of this vital steel-alloying metal (page 846).

The Province also pours out iron, gold, silver, cobalt, copper, and platinum—by value, a third of Canada's total mineral production. Ontario, in addition, leads all others in value of agricultural output, furs, and fresh-water fish.

Province Shows Frontier Spirit

Frontier vitality animates Ontarians. I felt it in remote mining and forest products towns. I felt it, too, near Niagara Falls, in one of the oldest settled parts of Canada (pages 833 and 835).

Deep underground, I watched workers completing the first of twin tunnels that soon would deliver Great Lakes water to the mightiest of all Niagara hydroelectric plants, the Sir Adam Beck-Niagara Generating Station No. 2. It is a 300-million-dollar project of the Hydro-Electric Power Commission of Ontario, known as "Hydro."

With Robert H. Saunders, chairman of Hydro, I picked my way through the cavern-like excavation, so big that scattered light bulbs seemed like stars in space.

"In these tubes Niagara River water, under hydraulic pressure, will flow *uphill* five-and-a-half miles to a surface canal," said chairman Saunders. "Downriver the water will drop through turbines into the Niagara gorge. Added to present capacity, the new plant will generate enough power to run two cities as large as your District of Columbia."

Big magic! Yet in remoter parts of the Province a little power has gone a long way to change habits and energize local economy.

Only four years ago, at Rossport on Lake Superior, local residents witnessed the inauguration of a new era for their town, population 250.

By the light of an oil lamp a Hydro official pulled a ribbon that led onto the community hall stage a very small girl carrying a very large stork (cardboard). In its [illegible] bore an electric light bulb. As the Hydro man threw the switch flooding the whole village with light, cheers almost drowned out the singing of "When the Lights Go On Again."

◄ **Detroit's Sunday Motorists Stream into Windsor, Ontario**

Canada's leading gateway, Windsor welcomes five and a half to six million U. S. visitors yearly. On August 2, 1951, Ambassador Bridge carried 9,500 automobiles out of Michigan. Almost 10,000 others bound for Canada used the tunnel beneath Detroit River, the world's busiest international waterway.

North Bay Children Clothe a Frozen Playmate in Dad's Old Shirt and Mom's Lamp Shade

Pets as Well as Children Attend This Rail-borne School in the North Woods

[illegible]

[illegible] Yonge Street, which is [illegible] and Fifth Avenue [illegible] the line [illegible] that per[illegible] the [illegible]

[illegible] Yonge [illegible] Wellington Street [illegible] Wellington [illegible] Parliament [illegible]

[illegible]

[illegible] Yonge [illegible] During the [illegible] Parliament [illegible]

[illegible] Zebulon [illegible] powder [illegible] for American troops fired the [illegible] building.

Ontario's Seat of Government

[illegible]

[illegible] and here [illegible] Lieutenant-Governor [illegible] Ontario [illegible] of the Province [illegible]

[illegible] Women's [illegible] for the Province [illegible] Children [illegible] child-care [illegible]

Indians Stolid, Dazed, and Skeptical, Receive Beaver Pelts in Berry Charade

[illegible]

[illegible] Royal Ontario Museum Expedition to Chubb Crater." In August of this year he [illegible] in northern Labrador another [illegible] of meteorite [illegible]

News papers [illegible] days in Toronto perhaps [illegible] the [illegible] of [illegible] [illegible] Toronto [illegible] [illegible]

Every year in late August and early September, Toronto plays host to an average of [illegible] visitors attending the Canadian National Exhibition [illegible] North America.

Simply "The Ex" [illegible] started as an itinerant agricultural [illegible] to Toronto [illegible] in [illegible] [illegible] now [illegible] [illegible]

Toronto's citizens are avid sports fans. Football is at least as popular as in the United

[illegible] Chubb Crater, [illegible] Museum [illegible]

states. But the spirit of sports in Toronto, as in Ontario and all Canada, is ice hockey.

On a winter visit, I had come from dark streets into the [illegible] of the Maple Leaf Gardens, home of the professional Toronto Maple Leafs [illegible] under [illegible]. [illegible] of [illegible] and the [illegible] of [illegible]. The puck [illegible] up and down the ice as players passed and stole it, checking abruptly and [illegible] the [illegible].

[illegible] the home [illegible] its [illegible] the Montreal [illegible].

From Toronto I [illegible] through what Canadians call "Western Ontario," the Province's [illegible] Golden Triangle [illegible] agriculture and industry [illegible] Lake Huron.

[illegible] of Ontario, the [illegible] north of [illegible] Superior and Huron [illegible] west of Western Ontario. The name persists from a time when all of the Province that counted was the St. Lawrence River and lower Great Lakes regions.

[illegible] of what is now Ontario was part of the [illegible] New France which the 1763 Treaty of Paris ceded to Great Britain. For a century and a half before, explorers like Champlain, La Salle (murdered by his men), Nicolet, Brulé (killed and eaten by Indians), and Radisson had urged their paddlers across this country to the Great Lakes and the Mississippi.

822

These Polar Relics Survived 47 Arctic Winters

[illegible]

Ontario's Settlement Had Slow Start

The first English settlement (1780) on the Niagara River [illegible] was swelled by Loyalists fleeing the United States during the American Revolution and after. In 1812 the population of Upper Canada [illegible] [illegible] [illegible] [illegible] 1867 [illegible] [illegible].

[illegible] Queen Elizabeth Way [illegible] the [illegible] my exit from Toronto.

This route parallels a growing industrial empire reaching from the [illegible] to Hamilton. [illegible] [illegible] [illegible] [illegible] [illegible] Toronto.

Hamilton, "Pittsburgh of Canada," marks the west tip of Lake Ontario with industry [illegible] smoke. But the city has public gardens of striking beauty, too (page 841).

[illegible] rolling mills of the Steel Company of Canada [illegible] at the [illegible] [illegible].

[illegible] plants have built up Hamilton to the Dominion's fifth largest city in Ontario [illegible] Toronto [illegible].

The Province's [illegible] interests far [illegible] H. B. Greening, for example, [illegible] president of the B. Greening Wire Company, was fully as eager to talk to me about

motorboats (he has owned 28) and hunting cheetahs (he may own one of these by now!) as about his firm's production of wire rope and screening.

Behind Hamilton lifts the sharp wall its residents call "the Mountain." It is part of the Niagara escarpment that shelters between its steep rise and Lake Ontario one of Canada's richest fruit belts, growing luscious peaches, strawberries, and grapes.

West of Hamilton I came to Brantford, bustling industrial city, home of internationally known Cockshutt Farm Equipment.

A crossing of Grand River, called "Brant's Ford" for the Mohawk chief Joseph Brant, named Brantford. The British government in 1784 granted the Mohawks and other Iroquois Indians land along Grand River in recompense for New York State homes and farms lost during the American Revolution.

Walter Rutherford, genial interpreter of Brantford history, took me out to Ohsweken, chief town of the near-by Six Nations Indian Reserve (page 842). George Green, Chief Little Bear, showed me where the Indians hold their remarkable "snow snake" races.

The Indians in winter build up a low snow bank a mile long, grooving the crest with a shallow trough. This icy track dips, rises, and gently curves, usually following a road.

Object of the contest is to propel a slim, 7-foot, hardwood wand, the snow snake, as far as possible along the track. The snake slides forward with painted eyes, its head weighted and banded with copper or lead. A finger groove notches the throwing end. Each Indian, holding his snake much as a pole vaulter grips his pole, sprints toward the end of the trough and launches the highly polished stick, crying "Han-you, han-you!"

Beware the Striking Snow Snake!

When a darting stick jumps the track, spectators scatter lest they be impaled. A game is two throws by each contestant; the winner, the player who gets the best distance, may propel his snake almost the full mile.

At Tutelo (Tutela) Heights, on a bluff above Grand River, we visited the house where Alexander Graham Bell ventured with his parents. From near-by Paris, the inventor of the telephone on August 1876, he sent his assistant across town to Brantford, say, "Yes, Alex, it is I, your father speaking"—Canada's first "long distance" call over wire. This followed his first transmission of speech by telephone in Boston on March 10, 1876.

A monument to Dr. Bell, who was one of the original members of the National Geographic Society when it was founded in 1888, dignifies a Brantford park. And at Tutelo Heights on September 12, 1956, two of his granddaughters, Mrs. Lilian Grosvenor Coville and Mrs. Nancy Bell Fairchild Bates, unveiled a new monument which designates the homestead a National Historic Site of Canada.

Amid farmlands dotted with dairy herds and studded with the fountain shapes of elms lie Kitchener and Waterloo, twin cities that form the hub of a cluster of market and manufacturing towns—Guelph, Elmira, Stratford, Preston, Hespeler, and Galt. Guelph is seat of the Ontario Agricultural College.

With a Kitchener businessman I visited a few of the 169 local industries. Almost all, I learned, sprang up from small shops where a man and his sons or brothers worked with bare hands, a few tools, and a knack for making something useful.

Rubber and Insurance Centers

Today furniture plants and textile mills; tool and other metal works; glove, shoe, and leather-goods shops; electrical appliance firms; and the needle trades carry on that craftsman tradition. Kitchener, home of B. F. Goodrich and Dominion Rubber, is also a Canadian leader in rubber products.

Contrasting with this industrial bustle is Waterloo's status as "the Hartford of Canada," with home offices of six insurance companies. Kitchener has restored as a shrine the steep-gabled boyhood home of the late William Lyon Mackenzie King, Canada's Prime Minister for 21½ years.

Men with beards and wives with bonnets or prayer caps, many clad all in black, stroll Kitchener and Waterloo streets. Half or more of the cities' people are of Pennsylvania Dutch ancestry, descendants of emigrants from Pennsylvania's Lancaster County, mostly between 1800 and 1840. Until World War I, Kitchener was called Berlin.

[illegible] rising in custom and belief are the Old Order Mennonites [illegible] refuse to wear buttons, feeling they make too much show (page 838).

One Sunday morning, on an earlier visit, my

(Text continued on page 837)

Canadian Mounties Guard Peace Tower in Ottawa

A melodious Swedish carillon gives the 100-foot memorial to the dead of World War I a voice as familiar to Ottawa residents as Big Ben is to Londoners. The electric sign, which says "Long Live the Queen," is French Canada's salute to Elizabeth II.

Red serge tunics and yellow-striped breeches are dress uniform for Royal Canadian Mounted Police detailed to Parliament Hill. In extreme cold they wear shaggy buffalo coats and muskrat caps. A few Mounties still function on horseback; far more in cars and motorboats, on motorcycles and dogsleds

Ottawa's Towers of Government Face the Factory Chimneys on Hull Quebec

Sailboats Scud Across Toronto's Harbour in Lake Ontario. Towers of Canada's Second City Testify the Skyline

Toronto population [illegible] is a [illegible] it [illegible] St. Lawrence River [illegible] In the [illegible] Montreal' [illegible] Power [illegible] Toronto [illegible] Canada [illegible] 2 [illegible] machines and [illegible] Ontario [illegible] Niagara [illegible] Falls [illegible] Niagara [illegible] Mr. [illegible] [illegible]

4 Lumberlost Lodge Skaters Head a Race from a Social Party

[illegible]

5 Young Skaters Smile Approval at a Friend's Performance

[illegible]

Frost King's Glittering Touch Creates a Crystal Bower

[illegible]

Leatherworker and Canteen Girl Touch Up an 1860 Uniform at Old Fort Henry

[illegible]

Air Force, Navy, and Army Officers Teach at Canada's West Point

[illegible]

nest drove me out into the winter countryside. A bitter wind dusted ditches and fence rows with blowing snow. The landscape, though in January drab, looked etched and orderly. Clustered farm buildings were like buttons gleaming in the rumpled quilt of fields and woodlots.

We were bound for Conestoga Meetinghouse, a place of Mennonite worship beside the Conestoga River. Names of both are a slightly different spelling of Conestoga, Pennsylvania, from which the covered Conestoga wagons rolled northward 150 years ago.*

When we arrived the service was still going on. The yard held 145 black buggies and seven black two-horse rigs. Blanketed horses, standing in their traces, were tied to hitching rails.

Soon the doors opened and spilled out 400 adherents of the Old Order of Woolwich Mennonites. Men came out one door, women and children from another. Coats, hats, bonnets, scarves, stockings, shoes were black.

Sturdy parents stowed blanketed children on laps, at their feet, behind seats of the open buggies. At a smart clip, horses trotted out the gate. Dry grass along the ditches leaned before the gusty wind. Wives opened black umbrellas for windbreaks.

The procession streamed up the straight dirt road. Some turned left and some right at side roads. We stood watching until leafless groves and tawny fields swallowed the last [illegible]

It was a scene 100 years old, a Currier and Ives print come to life.

Around another Mennonite meetinghouse huddled perhaps a hundred automobiles, every one black.

England in Canada

Near the heart of Western Ontario stands London, on the Thames River, whose streets bear such names as Oxford, Waterloo, and Piccadilly. The University of Western Ontario is here, and Springbank Park, one of Canada's loveliest. A multitude of thriving industries makes everything from locomotives, hardware, and refrigerators to beer, biscuits, and breakfast foods.

At Sarnia, the St. Clair River, outlet of Lake Huron, separates Ontario from Michigan. The Blue Water Bridge arches over the purrying waters to Port Huron, Michigan. An international port, Sarnia had calls last year from ships of nine European countries.

Expansion of fuel, chemical, and synthetic-rubber industries has doubled Sarnia's population in the last eight years. Here rise steel trellisework and convoluted piping of the refinery of Imperial Oil Limited that pulps Alberta petroleum delivered by tanker. East ward from Sarnia a pipeline carries oil products to cities of the Lower Lakes.

"An oil gusher drilled in 1861 at Oil Springs 20 miles southeast of Sarnia was among the first commercial wells in North America," Dr. J. L. Huggett of Sarnia Refinery told me. "We still have productive wells there, around Petrolia, Oil City, and Oil Springs, but they're dwarfed now, of course, by the Alberta fields."

Versatile Synthetic Rubber

Polymer Corporation Limited, Canada's only synthetic rubber manufacturer, buys light hydrocarbon gases, including ethylene and butylenes, from Imperial Oil next door and sells by-products to neighboring Canadian Dow Chemical.

For Polymer's 30 types of rubber the market is reliable: three-fifths of all new rubber consumed in Canada is synthetic.

"Here's a list of some 870 articles made of synthetic rubber," said Polymer's sales [illegible] "You'll find not only tires and tubes, but also brief- [illegible] bowling balls."

None of these remotely resembles the creamy curds I watched form in the coagulation tanks or the amber-colored rubber "crumb" and sheets feeding off the dryers.

At Windsor I reached Ontario's—and Canada's—southernmost projection, the peninsula between Lake Erie and Lake St. Clair.

Windsor, Canada's Detroit, stands just across the Detroit River from the U. S. city whose chief industry it has made its own (page 822). Here are the principal plants of Ford Motor Company of Canada and Chrysler Corporation of Canada. Windsor, in addition, is Canada's pharmaceutical capital, with Parke-Davis, John Wyeth, Sterling Drug, and R. P. Scherer all based here.

Fronting on the world's busiest inland waterway, Windsor stands also at a major rail and air crossroads. It faces a growing export outlet for its 470 industries in the U. S. Middle West, and at its back door lies the richest farm and city market in Canada.

With James Dykes of Windsor's Chamber of Commerce I watched riggers finishing a steel tower for a cross-river power line between Windsor and Detroit. As we moved through tall grass and reeds for a closer view, a handsome ring-necked pheasant rose in a whir of wings.

"You've got so much game it gets underfoot even in your cities!" I exclaimed.

"Or else the survivors have discovered that

* See, in the NATIONAL GEOGRAPHIC MAGAZINE, "In the Pennsylvania Dutch Country," by Elmer C. Stauffer, July, 1941, and "Pennsylvania Dutch Folk Festival," by Maynard Owen Williams, October, 1942.

Amish Folk in Waterloo View a Conestoga Wagon Twice Their Age

[illegible]

Main Street is the only [illegible] American hunters," [illegible] wrote [illegible] Canada's "Sun Parlor" [illegible] Waterloo. Here is Ontario's [illegible] richest farmlands, producing [illegible] crops and [illegible] dairy herds. Along Berlin's [illegible] Dominion Rubber [illegible] Lake Louise, Hiram Walker, the distillery [illegible] Canadian [illegible] Company.

Northwest to Lake and Forest

Returning to Toronto, I [illegible] through Lake Huron [illegible] Ontario [illegible] Lake [illegible] Superior [illegible] The first stage [illegible] Sault Ste. Marie [illegible] Algoma [illegible] Lake Superior [illegible] low and [illegible] grown [illegible]

[illegible] Canadian [illegible] Sault Ste. Marie across the St. Mary's [illegible] Sault Ste. Marie across the St. Mary's River to Lake Superior to Lake Huron's [illegible] Tides and currents [illegible] the Northern [illegible] long, [illegible] of a school [illegible]

[illegible] Lake [illegible] & Upper Canal [illegible] and Algoma Steel Corporation [illegible] the National Park [illegible] Algoma [illegible] Sault Ste. Marie [illegible] Canada's [illegible] Sault Ste. Marie [illegible]

[illegible] Canadian [illegible] Sault Ste. Marie [illegible] Algoma [illegible] Sault Ste. Marie [illegible]

[illegible] and [illegible]

[illegible] Sault Ste. Marie [illegible]

Swords Clash in the Shakespearean Festival at Ontario's Stratford

[illegible]

[illegible] "ought" [illegible]. He won't say "our" [illegible] places [illegible]. We [illegible] 12 [illegible] and [illegible] have [illegible] beyond the [illegible] line.

I [illegible] whether he was playing in Canada or the United States!

[illegible] Algoma Central and Hudson Bay Railway [illegible] the new [illegible] Marathon, [illegible] between 1936 and [illegible].

The same is true at Marathon Paper Mills of Canada, now supports most of the 2,000 people of the [illegible] town it brought into being.

The mill's wood comes from river drive and [illegible] forests as far as 180 miles north [illegible] pulp [illegible] plants in Wisconsin [illegible] packaging.

Remoteness Breeds Self-sufficiency

[illegible] the [illegible] of Marathon. [illegible] paper [illegible] the [illegible] town. [illegible] new [illegible].

Remoteness [illegible] activities for recreation and self-improvement.

Delmer Earle, director of recreation, showed me handicrafts shop, bowling alleys, billiard room, and library of the Community Hall, and told me about his winter ballet school, weaving classes, and dramatic club.

Mill manager Grant Ross typifies the self-sufficiency and versatility that become second nature in far-off Marathon.

Ross's daughter grew interested in stars, so he built a 6-inch reflector telescope. A frieze of handmade model autos, perfect in detail, decorates his living room, and he showed me gems and local stones he'd cut and polished. When talk slowed down, Ross stepped to an electric organ and played, beautifully, a half-hour of melodious classics.

"Where'd you take lessons?" I asked.

"Taught myself," said my host.

Clifford Graham is Marathon's police chief and fire chief, too, a dual role that gave him a memorable morning shortly before I met him.

A woman—call her Mrs. Jones—phoned Graham's home at 5 a. m. to report her house filled with smoke from paper burning in the furnace. Graham, half asleep, reached for the nearest clothing, which happened to be his police chief uniform.

"Nothing wrong here," said Graham, arrived at Mrs. Jones's. "Just open the flue and the smoke'll clear right up."

Hardly back in bed, Graham was awakened again, this time by a fire alarm calling him back to the same address. Graham gritted his teeth, donned his fire chief uniform, and rode the fire truck to Mrs. Jones's.

More smoke. Mrs. Jones more excited. "The police chief was just here," she reported. "He said nothing was the matter. Now see what's happened!"

"Oh, him!" said Graham scornfully. "I don't believe that ignorant fourflusher. He doesn't know a fire from a Shriners' parade. I'll open this furnace flue, and you'll be breathin' fresh air in no time."

The distraught lady expressed her thanks, and fire-and-police chief Graham walked down the path, still anonymous—he was sure—to Mrs. Jones.

Headlight Dazzles Moose

The caboose of a fast freight carried me westward to Terrace Bay. "Extra 4017 West," with two Diesels up front, hauled 70 cars loaded with 881 tons of autos, car wheels, farm machinery.

"You should be up ahead with the engineer," said conductor George Gordon. "Every train scatters moose and bear. By the time the caboose passes, they're gone in the bush.

"Locomotives kill 'em by the dozen, mostly at night. Moose seem dazed by the headlight. They'll stand there, stubborn, and try to face down tons of steel moving 50 miles an hour."

"Why do they come out on the tracks?"

"Some say the Diesel engine horn sounds like a moose call and draws 'em onto the track. A lot come out of the bush just to lick up the salt that drips on the ties from refrigerator cars."

Knocked Out by a "Buck Amuck"

Later I heard of a railway lineman who was knocked out and off his moving gas speeder near Sioux Lookout by a frightened deer. Coming to, he stumbled to a way station and got first aid for the sharp attack of "buck amuck." His unmanned speeder, jammed in a switch, was blasted loose by an express.

Terrace Bay, still shiny new in bright paint, had the same genesis as Marathon: spruce-clad hinterland, rail and water transportation, United States demand for paper products. The Longlac Pulp and Paper Company, a subsidiary of Kimberly-Clark of Neenah, Wisconsin, operates Terrace Bay's big sulphate mill whose output of bleached pulp goes to the United States for fabrication into paper and tissue products.

In youthful Terrace Bay nearly half the children are below school age. Of the 350 schoolgoers, only 50 were old enough for high school this fall.

Nipigon River once foamed and swirled from Lake Nipigon to Lake Superior. Its waters, a mecca to fishermen, gave up the world's record brook trout, a 14½-pound fish caught in 1916.

Today three power dams have gentled the Nipigon until it has little white water left. Pulpwood, run downstream by the thousands of cords, also discourages anglers.

Though the days of its superlative sport are past, the Nipigon still gives up fine fish. At Pine Portage powerhouse a fisherman unrolled wet newspaper to show us three brilliant-hued speckles, trout fresh from the river.

"The two big ones'll weigh between five and six pounds," he said. "The smallest won't go much over three."

At Lake Nipigon's outlet I watched the tug *Nipigon* of the Abitibi Power & Paper Company spill into the river a boom of 7,600 cords of spruce pulp logs worth $150,000.

The pulpwood sticks floated free in a "log" of boom logs chained end to end. Skillfully the *Nipigon's* skipper nudged the raft of wood toward the river channel. From a steel-hulled

(Text continued on page 556)

Paths of the Rock Garden in Hamilton Wind Among 4,000 Species of Plants

Hart House Is the Social Focus of the University of Toronto

Indian Mask Grins Toothily

Tourist's Skyscrapers

[illegible]

Baby Seals Replace Carriages in the Snow Country

[illegible] in Kapuskasing, [illegible] in Ontario [illegible]

Brooms Smooth Ice for a Curling Stone Nearing the "Button"

[illegible] at Sault Ste. Marie, Ontario [illegible] Canada [illegible]

◄ Red Eyes Wasp
Pretty Lovers
on Silver Cascades
by Day and Night

[illegible]

► A Pedipwood Local
Passes a Snow Road

[illegible]

work boat, men swung open the downstream side of the boom like a gate. Against the upstream side the *Nipigon* pushed with all its power, "punching the log."

A logger, dancing on a boom timber, called out, "Shove her, boy! Shove her til she says [illegible]"

Yielding to wind and current, the mass of pulpwood slowly moved away on a new leg of its journey to the mill.

On the northwest shore of Lake Superior I came to Port Arthur and Fort William, cities Ontarians lump together as the "Lakehead." They grew up at a historic beachhead, where early fur traders shaod level curves and peaks and struck out overland, then on by lakes and streams to the Lake of the Woods, Winnipeg, and the wild northwest.

Transfer of goods between Great Lakes and the Canadian West still is the Lakehead's primary reason for being.

Between them, Port Arthur and Fort William run an ore-loading rock, four newsprint mills, and 25 fluted, cubistic grain elevators.

Grain Elevator a Dusty Giant

Wearing a white smock to keep off grain dust, I went through Saskatchewan Pool 7 elevator, which projects 1,300 feet into the lake to allow ships to load direct. If cut in half horizontally, the beehive interior would reveal 810 "cells," or bins.

I watched automatic dumpers tilt loaded grain cars to empty them as a man might tip a box of sugar. Before shipping, Pool 7's nine million bushels of wheat, oats, rye, and barley would be sorted into 150 grades.

At Steep Rock Iron Mines, 1.5 miles west of the Lakehead, I stood on the brink of a rusty excavation 500 feet deep and 200 yards wide. We watched power shovels far below dumping 7-ton bites of iron ore into burly Diesel trucks. A company engineer pointed out wave-worn shores hundreds of feet above the present workings (page 851).

"Ore we're scooping up now once lay under 150 feet of water, 80 feet of blue clay, and 100 feet of iron ore already removed," he said. "Ancient glaciers had cropped chunks of ore in the bush round about. They were clues to iron under Steep Rock Lake.

"Before mining could begin, our engineers had to blast out a bypass to divert the river feeding the lake, pump it out, and dredge away the thick layer of clay, rubble, and mud overlying the ore."

All these steps, each Gargantuan, in time were taken. From the exposed lake bottom were retrieved an old double-bitted ax and musket, a silver watch, and a chest empty save for a Union Jack and a rubber ball.

The erstwhile lake bed has revealed a far more valuable treasure, high-grade iron ore deposits totaling perhaps a billion tons. Open-pit mining has already yielded more than nine million tons. Underground mining, recently begun, will supplement open-pit operations.

South of Steep Rock Les Quetico Provincial Park, an unspoiled recreation area of pine-clad camping sites and fish-filled lakes. All of far-west Ontario is a sportsman's paradise.

Ontario, in fact, suffers from a surfeit of wilderness play space. Recently, the provincial government had to declare northernmost reaches amounting to a fifth of its territory a "hinterland area." Entry to them by anyone not a resident is prohibited. Reason for the restriction is to avoid the expense, effort, and occasional bad feeling resulting from searches (sometimes in vain) for lost sportsmen and inexperienced adventurers.

Ontario in Cross Section

An air and train trip from Toronto 500 miles due north to James Bay taught me more Ontario geography.*

Near Lake Simcoe my [illegible] landed behind. Below lay the dissecting line between softer, more recent geologic strata and the hard edge of the Canadian (or Pre-Cambrian) Shield, with its ancient, flinty rocks, nubbly landscape, and countless lakes. To the north, in the Shield, farming is generally unrewarding, but forests millions of acres in extent grow spruce, pine, birch, and poplar.

Cars moving northward along Highway 11, escape route from cities' heat, were headed for lake shores dotted with cottages and inns.

Far west I could see Georgian Bay but not the bass and muskies that frequent its ledgy shallows. Ahead lay that principality of play, the Muskoka lakes and Lake of Bays, and presently we skirted the edge of lake-splashed Algonquin Provincial Park. Everywhere the sun beat down on a holiday land of perennial enchantment, as popular with U. S. visitors as with Canadians.

After a brief halt at North Bay, scene last

A Staircase of Locks Lifts Boats in Rideau Canal

This waterway connects the Ottawa River at Ottawa with Lake Ontario at Kingston. It was built [illegible] John By as an emergency route in 1827 [illegible] feared Americans might blockade [illegible] commerce. England shipped kegs [illegible] to meet the canal's payrolls.

Beyond military or commercial use, the Rideau today finds pleasure boats and canoeists. Far-travelered *Royal II* honored Elizabeth II during Ottawa's celebrations of her Coronation last June.

[illegible]
Kodachrome by National Geographic Film [illegible]

* See "Map of Canada, Alaska, and Greenland," a supplement to the NATIONAL GEOGRAPHIC MAGAZINE for June, 1942.

spring of a uranium flurry when townsmen vainly swept their yards with Geiger counters, the plane crossed the campers' paradise of Lake Timagami. Soon northern Ontario's chief mining region came into view. There lay the silver town of Cobalt, and then we flew between Canada's richest gold-producing areas, Kirkland Lake-Larder Lake and the mineralized rock reef known as the Porcupine.

Timmins in the Porcupine district, "the biggest town in Canada," never has been incorporated as a city, despite its 27,700 population. Here, under moss of a portage route, so goes the story, Benny Hollinger and Alec Gillies in 1909 found lump gold that bore the imprint of the boot calks of generations of trappers and fur traders. Today, Hollinger Consolidated Gold Mines, at the site of the discovery, is Canada's second most productive, surpassed only by Kerr-Addison Gold Mines in the Kirkland Lake district.

Between touch-down at Porquis Junction and flight's end at Kapuskasing the spruce forest reached unbroken to the flat horizon.

At Kapuskasing, an orderly paper mill town, new home developments intrude on the surrounding sea of forest, like coral colonies building out a reef (pages 844 and 852).

Nursery Grows 20,000,000 Trees

I watched Spruce Falls Power & Paper Company pulp cutters nibbling away at timber limits that cover an area bigger than Connecticut (page 847). The company hopes tree growth on this vast reserve will keep ahead of cutting, fire, and insect damage.

To hedge their bet, however, they already have set out several million 4-year-old spruce raised from seed at their own Spruce Falls Forest Nursery, where I saw 20,000,000 trees growing, many less than an inch tall.

At Camp 68 we lunched with woods workers on tomato juice, soup, three kinds of meat (including steak), potatoes, carrots, pies, jelly roll, canned plums, coffee.

Woods life, while no bed of roses, differs mightily from its rugged prototype of not-so-long-ago. Base pay, for one thing, has gone up 60 percent since 1945.

"Camp 68 is typical of living conditions now," Fred Flatt, woodlands manager for the company, told me. "You saw the panel buildings, modern plumbing, and bunkhouses free of crowding. Why, we even issue flannelette sheets and pillowcases.

"Some change from the old days," Flatt went on, "when the men slept crossways on long double-decker sleeves, climbing in over the footboards. 'Muzzle-loading bunks,' we called 'em, where a spruce rail, the 'smoot n' pole,' separated each man from his neighbor. Bedding was hay or spruce boughs, food mostly sowbelly, beans, and dried fruit. Nowadays—well, you ate the r grub."

At Cochrane I boarded the Ontario Northland Railway's twice-a-week train, the "Polar Bear." Its passenger and freight cars run on Ontario's northernmost tracks to Moosonee near the foot of James Bay.

The 186-mile right-of-way is a trough between green walls of forest. It follows the Abitibi and Moose Rivers past sawmills, pulp-cutting camps, clusters of Indian tents. Passengers were mostly vacationists, woods workers, and Indians.

End of steel was close to the wide Moose River mouth, where the tidal fall, uncovers sand flats that force even a canoe to zigzag. Two days before our visit, we heard, Moosonee was Ontario's hottest spot, 92°. Yet a trader's wife told me ice floes still jammed the east coast of Hudson Bay.

By boat we crossed to the island where stand the white, red-roofed buildings of the Hudson's Bay Company's second oldest post, Moose Factory, founded in 1672.

It was Sunday, and I attended worship with Moose Factory whites and Indians in historic St. Thomas's Church. The Suffragan Bishop of Moosonee, the Right Reverend Neville Clarke, led this English service. His Cree language service would follow in the afternoon. Indian beadwork decorated moose-hide altar- and pulpit-cloths.

Kingston Epitomizes English Ontario

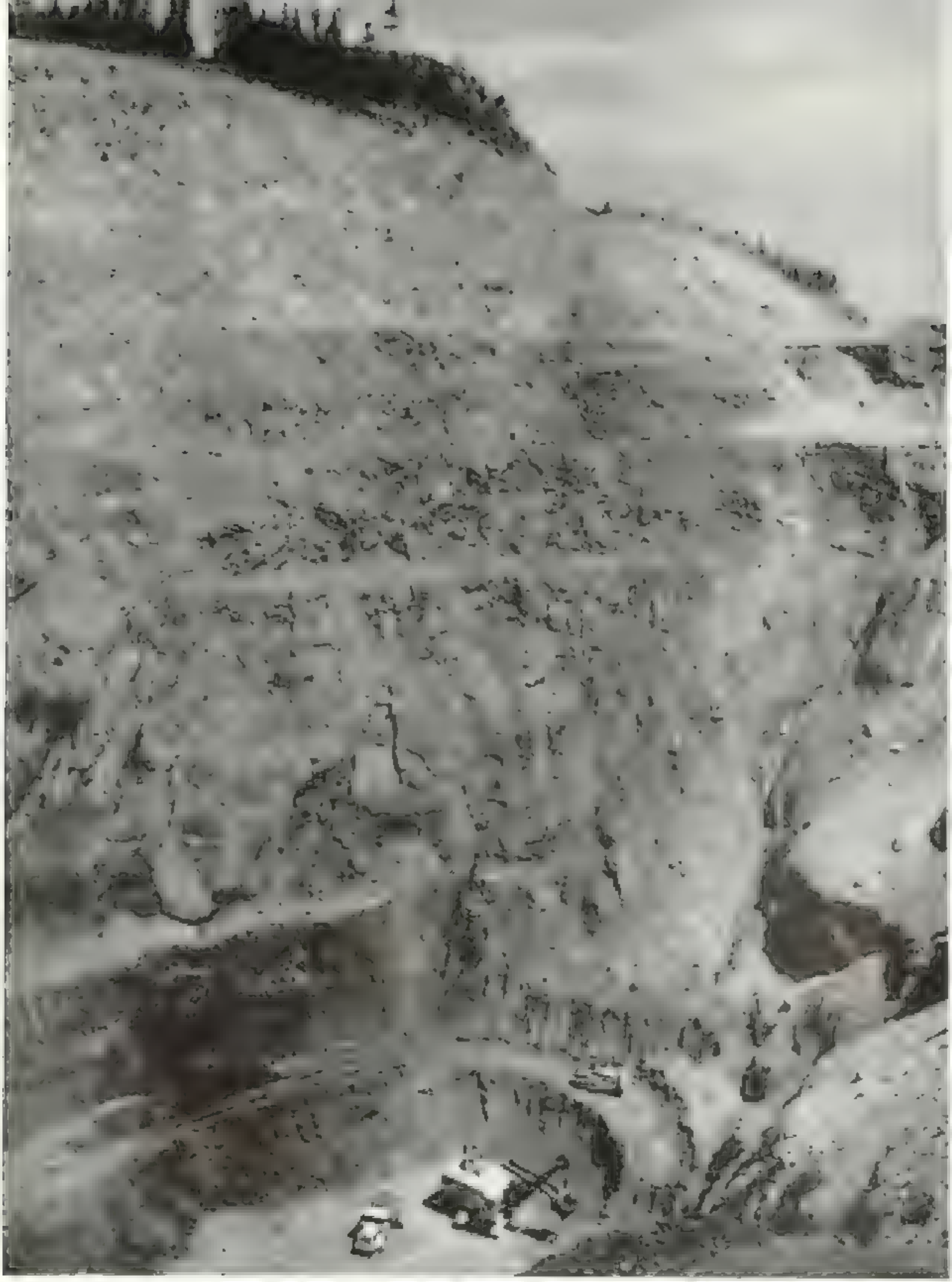
Back in the south, I turned into the last leg of my journey, through eastern Ontario to Peterborough, Kingston, and Ottawa.

Peterborough has given to canoes and boats built there a name as familiar to Canadians as is Old Town to Americans. The pleasant city stands on the Trent Canal where it overcomes Otonabee River rapids by a series of locks that include a 65-foot hydraulic lift, the world's highest with a lock chamber that rises and drops. Peterborough welcomes vacationists and fishermen to the Kawartha Lakes.

Venerable Kingston, capital of United Canada from 1841 to 1844, stands where Lake Ontario spills its waters into the St. Lawrence River and the maze of channels that create the Thousand Islands.

Kingston suggested to me an English shire town. Its brick buildings have solid dignity; small shops friendly unpretentious; leafy streets and parks a restful sense of the worth of time itself. Yet it's a busy city, with boat and locomotive works, a nylon mill, and the fabricating and forge plant of the Aluminum Company of Canada, Ltd. Here, too, is Queen's University, its ivied walls and shady walks reminiscent of old New England schools.

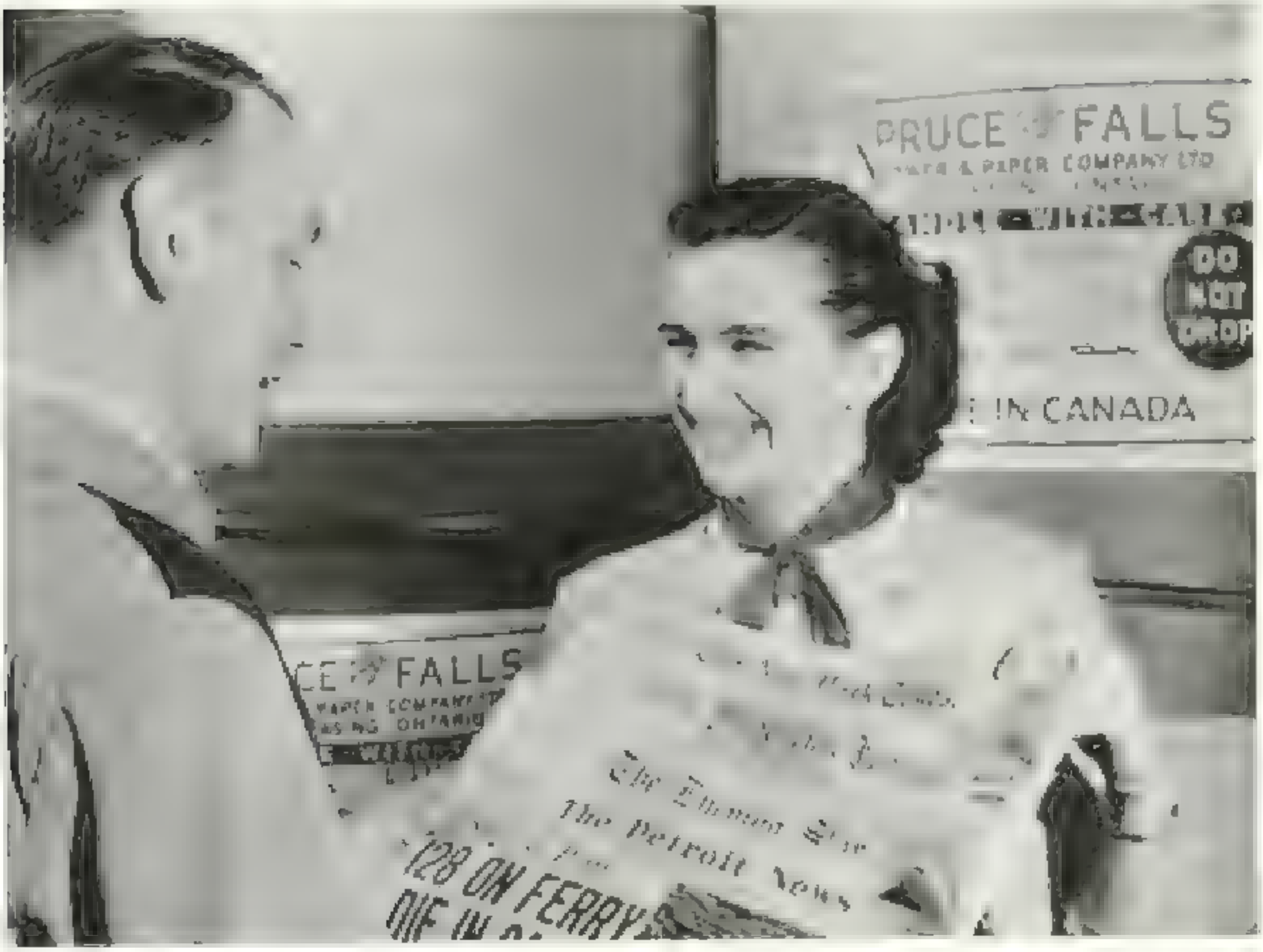
Kingston and military tradition are inexpa-



881

Engineers Diverted a River and Drained a Lake to Get Steep Rocks Redivivade Iron

[illegible]



Canada's Boundless Forests Yield Four-fifths of the Newsprint Used by U. S. Papers

[illegible] 49 percent of Spruce Falls common stock. Canadian newsprint enters the United States duty [illegible]

rable. Fort [illegible] 1673 And this was Canada's naval base in the War of 1812. Today, Kingston is the seat of the Royal Military College (page [illegible]). The old earthworks that squats Fort Henry, built in its present form between 1832 and 1836, its purpose was to defend Canada against a possible American invasion during the prolonged period of strained relations flowing the War of 1812.

[illegible] where the capital of Canada [illegible] the coming current of the river that shares its name—Ottawa.

[illegible] Parliament Buildings where elected legislators govern the 15 million people of the second largest country in the world, after the U. S. S. R. [illegible]

In Ottawa [illegible] Granular and [illegible] owned by Armour and Company [illegible] left with other relics at Cape Columbia, Ellesmere Island, by Admiral [illegible] pioneer, Robert E. Peary in 1905 (page 627).

A [illegible] stroll with Ottawa friends through [illegible] Hill Park, the Peace Tower carillonneur flooded the evening air with the [illegible] of his 53 bells. We [illegible] Hill (page [illegible]).

This outlook over the [illegible] seemed an appropriate reminder of federal responsibility and the wisdom of Queen Victoria's choice of this city as capital.

To east and south Ottawa stood shoulder to shoulder with the [illegible] of the nation, the [illegible] Canada [illegible] traditions. [illegible] much cash country [illegible] to national prosperity, but promising for the future much, much more.

[illegible]

Jericho Gives Up Its Secrets

Beneath a House in Earth's Most Ancient Town, Scientists Discover a Family Group of 7,000-year-old Portraits

By Kathleen M. Kenyon and A. Douglas Tushingham*

With Illustrations from Photographs by Nancy Lord

EARLY this year, as members of our joint U.S.-British expedition dug for the second season into the ruins of Neolithic Jericho, a human skull lay partly exposed in the side of one of our trenches. But one never goes burrowing about on ancient site just to remove things. Maintaining a straight, vertical edge on an excavation, so that layers marking successive settlements may be recorded accurately, is a cardinal rule of modern archeology. So there we left it.

Remains of Neolithic men are too important to be ignored, however. Neolithic means "new stone age," when man stood at the very threshold of his long march toward civilization. One of the objectives of our expedition was to learn more about these users of stone implements who inhabited Palestine 70 centuries ago. When drawings were completed in that area of the dig, where we had sliced through the ruins of one house built upon the tumbled remnants of another, we sent word to bring out the skull but to make as small a hole as possible in the side of the trench.

Peter Parr, in charge of digging in that area, appeared that evening with an astonishing object. It was a Neolithic skull all right, but the whole of the lower part was covered with plaster molded into human features. Eyes were inset with sections of shell. Central slits represented pupils. Cheeks were rounded and chubby, ears delicately molded, mouth prim. Only the nose was broken away.

Plastered Skulls a Surprise Link

Here was a missing link so unexpected that it had never been missed! No archeologist had even guessed at the existence of such a work of art, foreshadowing the great traditions of Mesopotamia, Egypt, and ancient Greece. We realized with a thrill of discovery that we were looking at the portrait of a man who lived and died more than 7,000 years ago.

One of these sculptured skulls would have been culmination enough for our two seasons' work, but more surprises were in store. Visible in the cavity from which Parr had removed the first skull lay two others. When these were removed, three more appeared (page 857). Behind them lay still another. We ended, a week after our efforts should have bowed to the advancing heat of a Jericho summer, with a family group of seven of these amazing portrait heads and an enormous hole in the side of our trench.

Jericho, whose ancient artists produced our seven portraits, owes its existence to that vitally important feature of the Jordan Valley—an unfailing supply of water. Elisha's Fountain ('Ain es Sultan) is honored by tradition as the very one into which the prophet cast his handful of salt, miraculously "healing" its waters (II Kings 2: 19-22). It flows to this day only a few yards from Old Testament Jericho's ruins (page 855). This gushing sweet water in the midst of the arid plain of the Jordan Valley has for untold centuries attracted wanderers to its side.

A Cradle of Human Culture

We had come to Elisha's Fountain and Jericho to learn what we could of man's cultural beginnings.

To Christians the world over, Jericho is familiar for the dramatic Old Testament description of its capture by the Israelites under Joshua. Its very name conjures up the familiar Biblical story: "So the people shouted when the priests blew with the trumpets: and it came to pass . . . that the wall fell down flat . . . And they utterly destroyed all that was in the city . . . with the edge of the sword" (Joshua 6: 20-21).

Our expedition hoped to illustrate the Bible's account with confirmation of the town's destruction by the Israelites. Literary evidence points to a date somewhere between 1400 and 1250 B. C. for the collapse of the wall before the Israelite assault.

Moreover, Jericho's ruins have thrown important light on man's first hesitant steps toward community effort. There was every possibility that Jericho might take honors as the oldest known town in the world.

Palestine, in which Jericho lies, is a land of contrasts. On one hand, Jerusalem and its ancient sister city of Samaria (Sebastye) perch high on rocky hills. In the Near East's brief

* The 1952 and 1953 Jericho excavations were sponsored jointly by the British School of Archaeology and the American School of Oriental Research, both with headquarters in Jerusalem. Dr. Kenyon, the expedition director, is Lecturer in Palestinian Archaeology at the University of London Institute of Archaeology. Dr. Tushingham, assistant director for both seasons, is an associate professor at Queen's University, Kingston, Ontario, Canada.

Arab Workmen Uncover the Many-layered Walls of Bronze Age Jericho

[illegible]

sometime the land bursts into color as green [illegible] on terraces built on the hillsides, then [illegible] again into the blinding gray-white of [illegible] limestone. Every possible [illegible] is cultivated, for Palestine is a stern country from which to wrest a livelihood.

On the other hand, rolling grasslands [illegible] out from 'Amman, capital of the Hashemite Kingdom of Jordan,* merging farther east into the [illegible] wastes of the Syrian Desert. Between these two borderlands, in the great gash of the Jordan Valley, lies Jericho [illegible].

The elevation of Jerusalem is [illegible] feet above sea level; of 'Amman, [illegible]. From either place a road descends a few miles through deeply winding valleys, then [illegible] downhill past signs in Arabic and English marking sea level, until it reaches Jericho, [illegible] feet below sea level, the lowest-lying town on the earth's surface.

As the road descends, [illegible] fields and [illegible] of olive trees [illegible]. [illegible] only for the [illegible] which [illegible] up after the winter rains.

Suddenly there appears the flat plain of

*See "[illegible] Jordan [illegible] Arab [illegible]" by John Scofield, National Geographic Magazine, [illegible]

855

Refugees Washing Clothes in Elisha's Fountain in Jericho and Small Girls

[illegible]

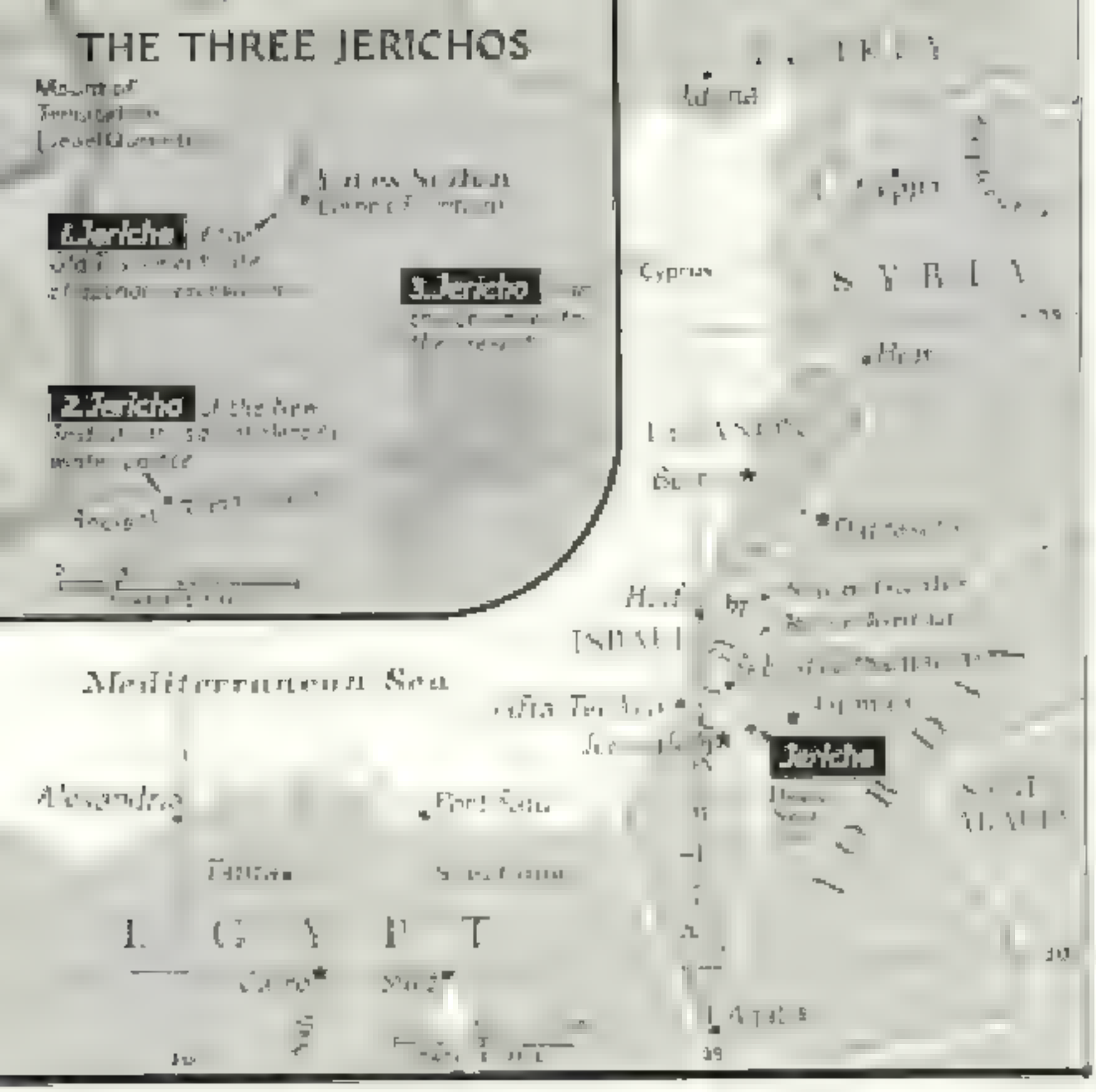
Jericho, the bottom of a great rift through which the River Jordan coils to lose itself in the Dead Sea. The center of the plain is a fantastic badlands where the river has twisted its channel between slimy white mounds. The landscape is glaring white in the sunshine and inexpressibly barren.

In the midst of this bleak plain Jericho stands out in startling fertility. Deep green fields of [illegible] gardens, palm trees, and [illegible] groves. [illegible] rises out [illegible] of a mile northwest of the modern town (page 860). Archeologists years ago discovered that the hill is actually a mound composed of layer upon layer of ruins deposited as successive towns rose, prospered, and fell beside the pleasant waters of Elisha's Fountain. These waters, carefully conserved [illegible] modern Jericho, [illegible] winter [illegible].

When [illegible] Jericho, [illegible] uncovered [illegible] of New Testament Jericho, where Herod [illegible] winter [illegible].

Ours was not the first [illegible] to [illegible] Old Testament Jericho's [illegible] German archeologists [illegible].

* See "The Ghosts of Jericho," by James L. Kelso, National Geographic Magazine, December, [illegible].



Earth's Lowest Town Was a Crossroads in Bible Times

Jericho, where ancient trade routes met, was the gateway to the Promised Land. Its destruction by Joshua's Israelites opened the way to the heart of Palestine.

An important center in New Testament times, Jericho was the scene of many incidents in the life of Christ. Tradition identifies Jebel Qarantal as the place of His temptation in the Wilderness. The winter palace of Herod stood near by.

A venerable Roman road over which courageous visitors now still drive up to Jerusalem is perhaps the one traveled by Jesus. The traditional place of His baptism is a spot on the River Jordan, a few miles away.

Situated 846 feet below Mediterranean level, modern Jericho is the world's lowest-lying town.

War I, and Prof. John Garstang led British expeditions between 1930 and 1936. These revealed much of the site's history and first told something of its incredible antiquity.

Seventy Centuries of History

Jericho's first families probably occupied the gentle slope above Elisha's Fountain even before 5000 B. C. By 1000 B. C. the walls stood at a height of 70 feet above the spring, crowning an impressive mound. For 4,000 years Jericho was a great fortified town, rising slowly from the plain as it rebuilt itself time after time on the remnants of its own past. When buildings and walls fell or were destroyed, the ruins were leveled and new structures built on them.

Into the rubbish that grew beneath the city went telltale evidence for today's archeologists, broken pots, rude implements, and bits of lost or discarded ornament.

Digging up the past is a round-the-clock job. Archeologists usually set up headquarters as near to their dig as possible. We live in an old millhouse beside Elisha's Fountain, a few yards from the eastern slope of the mound. Streams flow on either side of us; to them comes a constant procession of women from the near-by refugee camps.

Here, at 7 a. m., 50 laborers assemble daily to collect tools and climb up the *tell* (an Arab word for a mound marking an ancient site) which towers above our headquarters.

On the tell the laborers split into groups. Each has a man to break the soil, using a pick if the deposit is deep or a trowel if more delicate work is required. Another fills baskets. Laughing Arab boys, carrying baskets of earth to the refuse dump, climb stairs left in the sides of the trench (page 534). An expedition staff member in charge of each small group records everything found as the layers of soil are sliced away.

Palestinian expeditions are a far cry from the romantic, treasure-hunting concept of archeology. As often as not, a dig looks more like the start of a major construction project than a search for earth's buried secrets.

Our first task was to establish the dates of old Jericho's many defenses. Their main outlines had been revealed by previous excavations. Now, to learn the ages of these successive walls, a deep trench was dug from top to bottom through one side of the mound. Walls and city levels stood revealed on its vertical face in varying colors and textures. By carefully tracing the different layers in the soil, it was possible to determine which city was responsible for each wall.

One of the greatest advances of Near East archeology is the ever developing "pottery chronology." Like everything else in man's culture, pottery has undergone a slow, steady evolution since its invention some 65 or 70 centuries ago. A trained archeologist can determine, with considerable accuracy, the date of a level by examining the broken bits he

(Text continued on page 557)

[illegible] Plastered Skulls Depict Men Dead 2,000 Years

[illegible]

[illegible]

[illegible]

[illegible]

A Plaster Floor Buried 7,000 Years Gets a Scrubbing

[illegible]

[illegible]

Jerichoan Tombs Preserve Meat Prepared 35 Centuries Ago

[illegible]

[illegible]

Old Jerusalem Tumbled Ruins Lie Between Parched Mud Village and Green Oasis

[illegible]

Moses, Standing on the Distant Mountains, Glimpsed the Promised Land and Died

Later [illegible] and the people to shout; the wal[illegible]

Water Carriers Still Trudge in Dhahran Tomorrow as in Bygone Days

[illegible]

Arab Women Toil at the Spring

[illegible]

Grain Stored About 1500 B.C. Comes to Light A. D. 1953

dub in it. At Jericho each layer is stripped off separately; the pottery is set aside as an aid in dating the layer from which it comes. The results tell a fascinating story as our trowels and spades bring Bronze Age Jericho to light (pages 859, 864, 867).

Six months of hard work have gone so far into our investigation of the Bronze Age defenses of Jericho. As we removed one wall after another and realized that we were examining only a small segment of the circuit enclosing Jericho's nine acres, we came to realize the scope of effort expended by these ancient Palestinians in keeping their defenses in repair.

Repeatedly we saw places where a wall had been built 5,000 years ago, only to fail, be patched, then rebuilt, then strengthened in front and behind, and finally, when repairs [illegible] be replaced by another broader wall on top of its ruins. Not only in our day has security lain in preparedness!

The Early Bronze Age in Palestine lasted from about 3100 to 2100 B. C. This was the dawn of the "historical" period in Bible lands. During all this time Jericho was thickly populated and strongly defended. The ancient city lay at the gateway to Palestine from the east. Every invader crossing the Jordan came face to face with it, as did the Israelites.

Jericho's Walls Tumbled Many Times

During the thousand years of the Early Bronze Age the city suffered many vicissitudes. Jericho's walls were repaired or completely rebuilt no fewer than 16 times! The earliest wall was undoubtedly destroyed by an earthquake; we found it lying flat, fallen forward [illegible] the later walls probably suffered the same fate. Others may have been destroyed by enemies, as the latest of the 17 [illegible]

[illegible] of this last wall marks a great catastrophe for Bronze Age Jericho, as indeed it must have for the whole of Palestine. Its predecessor had collapsed, possibly because of an earthquake. While it was still in ruins there was clearly an urgent threat, for the last wall was hurriedly built of rough and broken materials. Before it was finished, disaster overtook Jericho.

The wall as we found it was destroyed so completely that the very stones of its foundations were split and blackened by fire. Brickwork was burnt bright red, and ashes of the conflagration, in striking shades of red, white, and pastel blue, were piled against the remains.

Without doubt this destruction marks the invasion of Palestine by a wave of nomads from the desert, which brought the great Early Bronze Age civilization to an end. The invaders, probably the Amorites, brought with them to Jericho an entirely different way of life. They cared nothing for the city architecture which had grown up in the thousand years of the Early Bronze Age; their houses were simple and flimsy. Their pottery was unlike that of the older inhabitants; their burial customs were austere. For 200 years progress in Palestine was halted.

During the next period, too—the Middle Bronze Age—Jericho's defenses tell us much about the people who [illegible] This was the time of Abraham and of Joseph—[illegible] 2000 to 1550 B. C.

Chariot Warfare Changed Defenses

About 1730 B. C. Asiatic invaders imposed their rule on Egypt and its territories, including Palestine. These Hyksos warriors are credited with having introduced chariot warfare.

Jericho's Middle Bronze defenses are distinguished by the introduction of a completely new system, in which the city wall was protected by a sloping ramp. It seems logical to associate each new system of defense with some new method of attack. This steep ramp would have been an excellent defense against chariot warfare by preventing the chariots from galloping up to the base of the wall before the defenders could mass.

The "newest" Middle Bronze Age city uncovered by our picks dates from about 1400 B. C. After this there is a tantalizing gap in our evidence. The invasion of the Israelites under Joshua must have taken place somewhere between about 1400 and 1250 B. C. Scholars cannot agree on the exact date; evidence from Jericho might solve the problem.

Wherever we dug, Late Bronze Age levels had disappeared. This is due partly to abandonment of the town for long periods, when the topmost levels tended to wash away during successive rainy seasons. We know from the Bible that Jericho lay unoccupied for several hundred years after Joshua's conquest. Partly, too, soil had been stripped from the mound for brickmaking and gardens until all the later areas were removed. Perhaps before the end of the dig we shall discover an answer to our questions about Jericho's most famous destruction.

Cemetery Is Fruitful Hunting Ground

Strangely enough, with the exception of our seven skulls few sensational finds have come to light in the Jericho mound itself. These ancient Palestinians left little behind them but shattered walls, discarded tools and utensils, and the masses of broken pottery by which we can estimate the age of their settlements.

Fortunately for archeology, however, primitive man venerated his dead. Ancient seme-

Patterned Pots and Dishes Are Calendars of Near Eastern Archeology

[illegible] the age of long-forgotten towns and cemeteries from the sty[illegible] [illegible] Dorothy [illegible]

day be reconstructed in the Amman museum [illegible] as we found it.

One of these Middle Bronze Age tombs stands out in our recoveries. The blocking of the door into the chamber was removed [illegible] the day's work ended. Immediately inside we found the principal burial lying on a wooden bier. It was draped with a finely woven rush mat which overlapped a 5-foot wooden table, the largest we have yet found. On the table was a wooden platter holding joints of mutton to which flesh still adhered. Baskets held combs and toilet requisites.

Wood and textiles were in excellent condition when the tomb was opened. As soon as the outer air reached them, they [illegible] [illegible] steps to preserve them.

We [illegible] [illegible] a Primus stove routed away, [illegible] of wax. These were passed through the narrow entrance to the [illegible] unceremoniously in the chamber, cleaned [illegible] wood with a camel's-hair brush. The [illegible] liquid was then poured on the objects, into which it sank with a sizzling sound.

[illegible] and bones we treated with [illegible] Great care was necessary [illegible] the liquid itself did not [illegible] material to collapse.

[illegible] working in the light provided by a high-[illegible] gasoline generator, we [illegible] against the ravages [illegible]

Skull Artists Were Town Dwellers

More important than the tomb discoveries, and overshadowing [illegible] Joshua's conquest, is the light Jericho [illegible] man's striving toward [illegible] Here is where our skulls fit into the picture. The men who decorated them were not [illegible] [illegible] Jericho [illegible] when [illegible] could be cultivated and made to produce more richly, and that certain animals could be kept

[illegible]

Arab Schoolboys Get a Dawnstorm Lesson in Israeli's Past

[illegible]

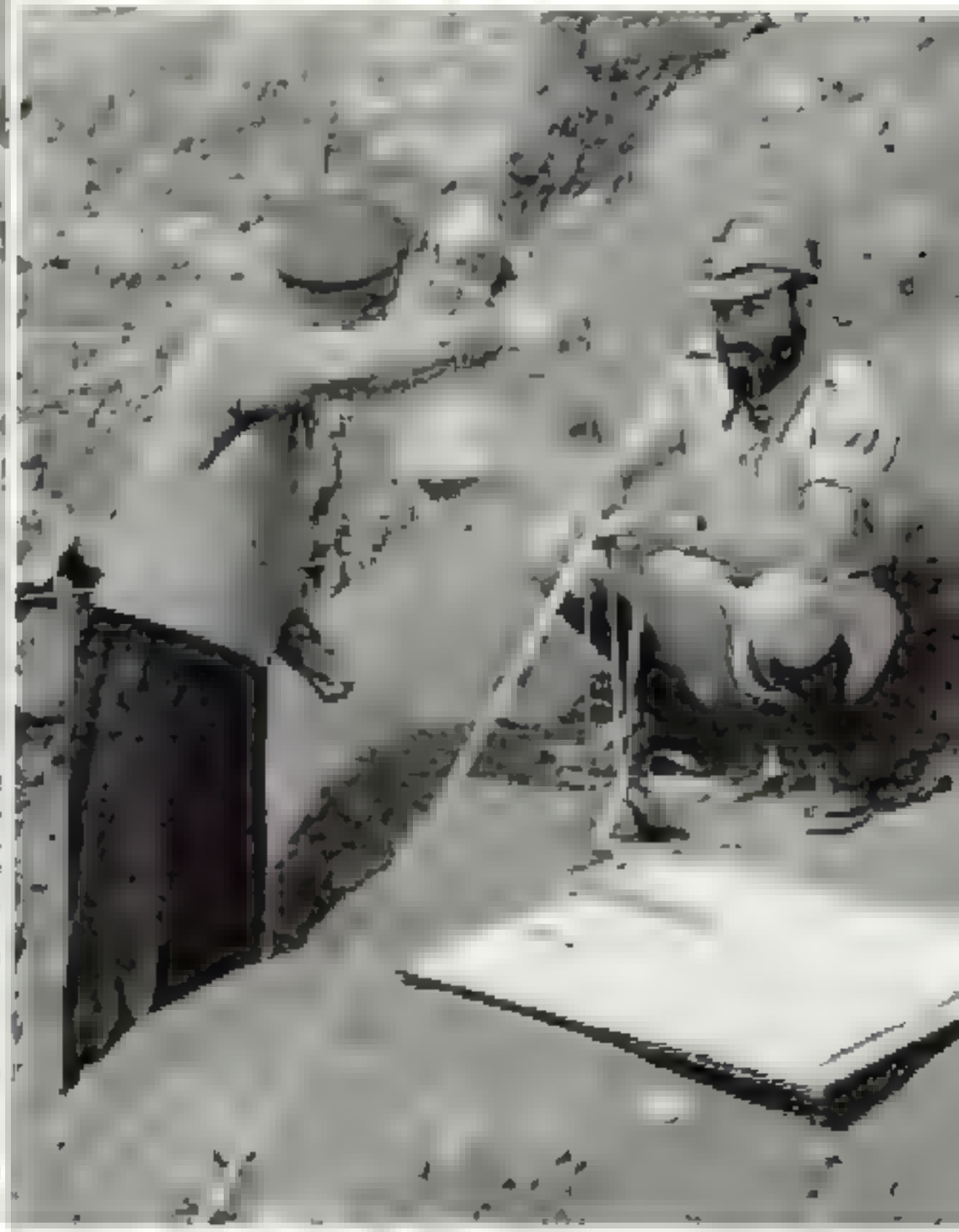
[illegible]

[illegible]

Physical Forms Appear Meaningless Morals as Poetry to the Uninstructed

[illegible]

[illegible]



in herds, could they settle in one spot and be assured of a food supply. From this time we can expect to find permanent dwellings and the development of arts and crafts, a most important one being the making of pottery. Archeologists have traced these developments back to two great river valley areas of the Near East—the Jordan, and the Tigris-Euphrates in Mesopotamia.

Our discoveries indicate that Jericho is the oldest town yet discovered in this key area of man's early development.

Neolithic Jericho Had No Pottery

The earliest level we have uncovered takes us back before the introduction of pottery, when food and water containers were laboriously worked out of stone or made of wood or skins. Yet already Jericho's buildings were elaborately constructed of hand-molded sun-dried bricks. Solid walls were covered with fine plaster.

Such buildings had been discovered by Professor Garstang near the spring, the obvious reason for these early agriculturalists to settle here. Our first big surprise was to discover houses of the same type half the length of the tell away, and on the side away from the spring. This meant that early Jericho was no mere village.

Another surprise was the discovery that Neolithic Jericho had been a walled town. Deep beneath the earliest of the Bronze Age walls we reached the top of a massive stone wall. Its base was only a couple of feet above bedrock. This belongs without doubt to the earliest Neolithic stage, before the introduction of pottery.

Even though lacking pottery, the inhabitants of Jericho were then a community, capable of organizing themselves for the great labor involved in erecting a wall. The stones—one of them nearly five feet across—had to be brought from adjacent mountains.

How early this was in years is guesswork; an estimate might be about 8000 B.C. Whatever the exact age, Jericho has a sound claim to the title of earliest known town in the world.

Stone Knives Still Sharp

In the debris of the houses we found many of the simple utensils and implements of Neolithic men and women, as evidences of the food they ate. Tools were of flint or occasionally of beautiful translucent obsidian. Knives, sickle blades, awls, and chisels are today sharp enough to cut.

Utensils are of stone; no doubt there were others of wood and skin. We found stone querns, with which grain was ground, mortars and pestles for pounding grain and vegetables, and stone bowls of every size from small and finely worked cups to large basins of hard granite. These must have required infinite labor to hollow out with the tools available.

Food was stored in pits sunk in the ground and carefully lined with plaster. Animal bones we are carefully preserving, so that experts can identify the breeds and tell us how far domesticated herds had been developed from the wild types from which they had originated not so very long before.

We can even glimpse the thoughts of these men who were taking their first steps towards civilization. One of the alterations to an elaborately constructed house converted a passageway into a small room. At one end is a small niche recessed in the wall, with a rough stone forming a pedestal at its base. Not far away, in the debris of the building, we found an elaborately worked block of volcanic rock, clearly imported from a distance. This exactly fitted into the niche.

Here we surely have one of the earliest known cult objects, perhaps worshiped as a symbol of the spirit of fertility of the earth. Small clay and mud figurines of domestic animals which we found may have been dedicated to the same religious purpose.

Skull Found Beneath Floor

Even more striking is the skull of an elderly man carefully set upright beneath the floor of a room in the angle of the two walls. Either he was an enemy whom it was desired to keep under control or a venerated member of the community whose wisdom it was hoped to perpetuate in the house.

Eventually, by comparing these 7,000-year-old relics of Jericho's past with the utensils and customs of primitive peoples of our own time, we may be able to reconstruct a fairly complete picture of life in Neolithic Jericho.

As for the seven sculptured heads, it is still too early to grasp the full significance of these amazing objects. One cannot help but feel that they are portraits, which bring the men of the earliest Neolithic period astonishingly to life. But why were they made? Probably they are survivals of some form of ancestor worship, in which their descendants attempted to preserve the personality of tribal or family elders.

Every day new details appear. As a third season starts, we face still another problem: Have we come to the bottom of all the Jerichos? Are there still older settlements beneath the one where we found our seven portraits? In due course we hope to find traces of the very first, men who settled beside Jericho's spring. Then we shall be very close indeed to the beginnings of civilization.

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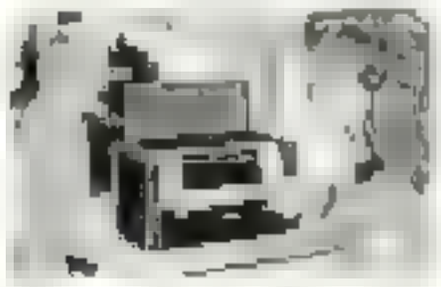

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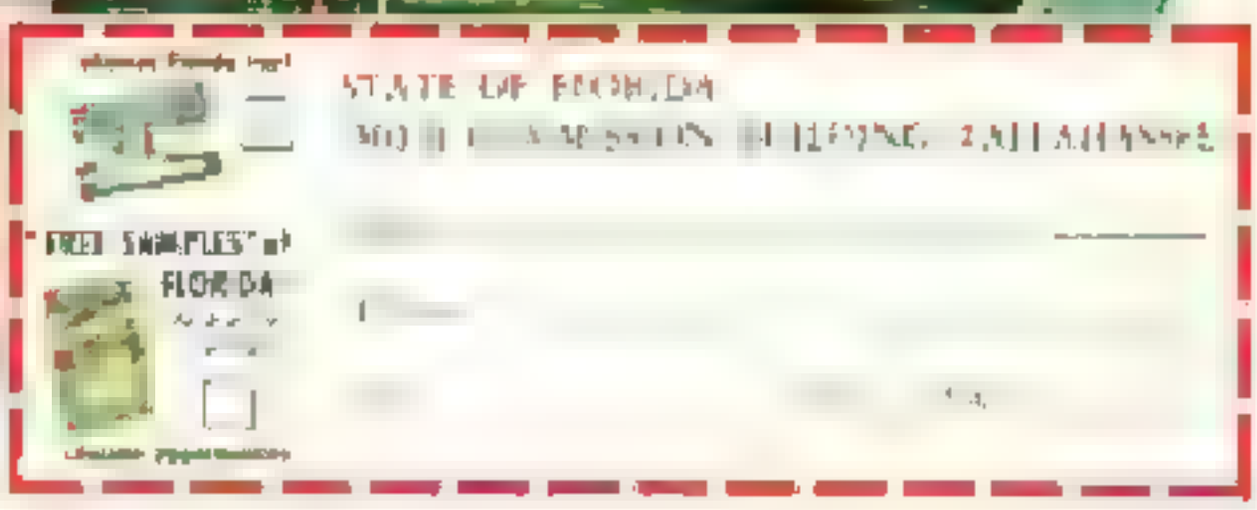

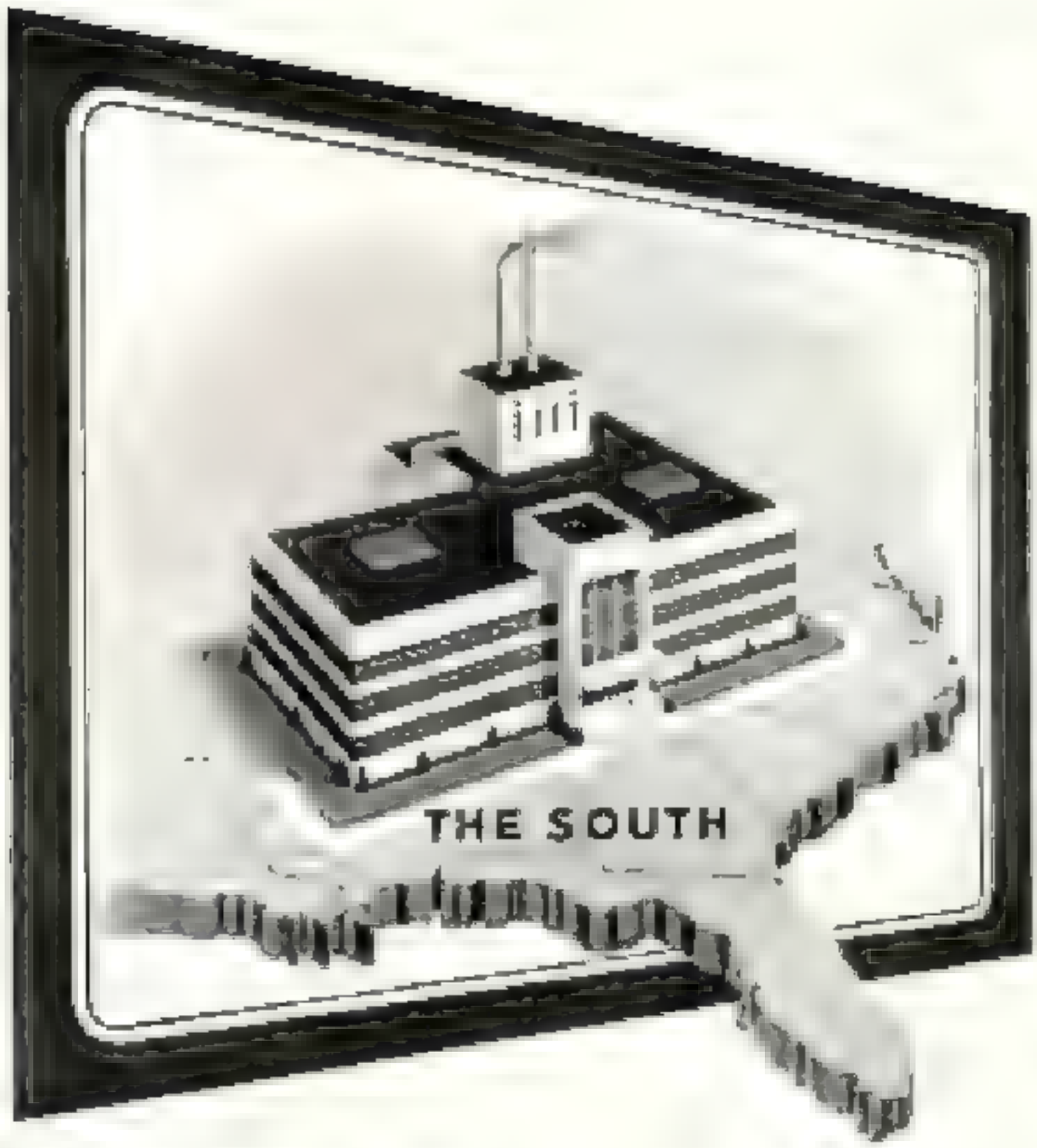

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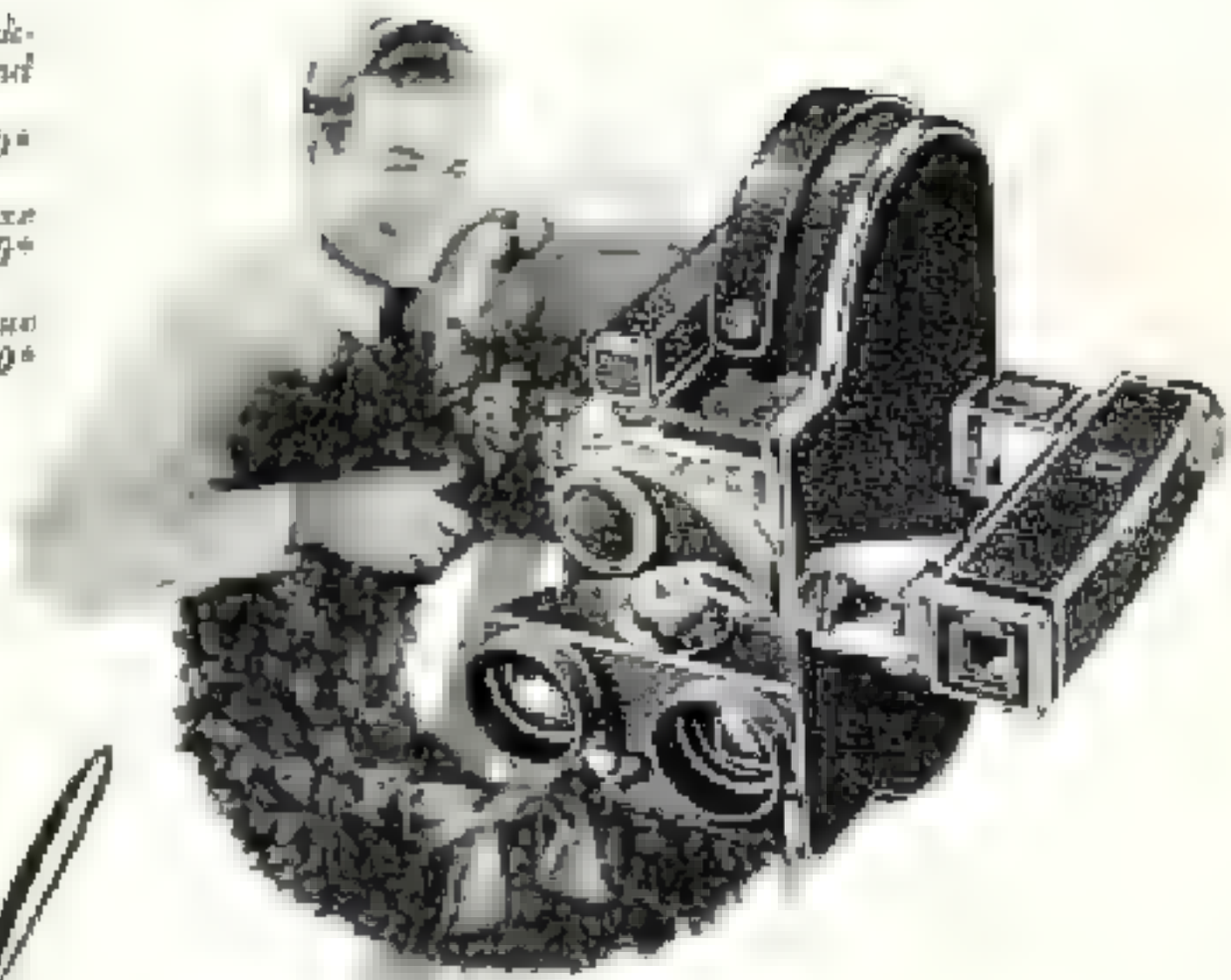

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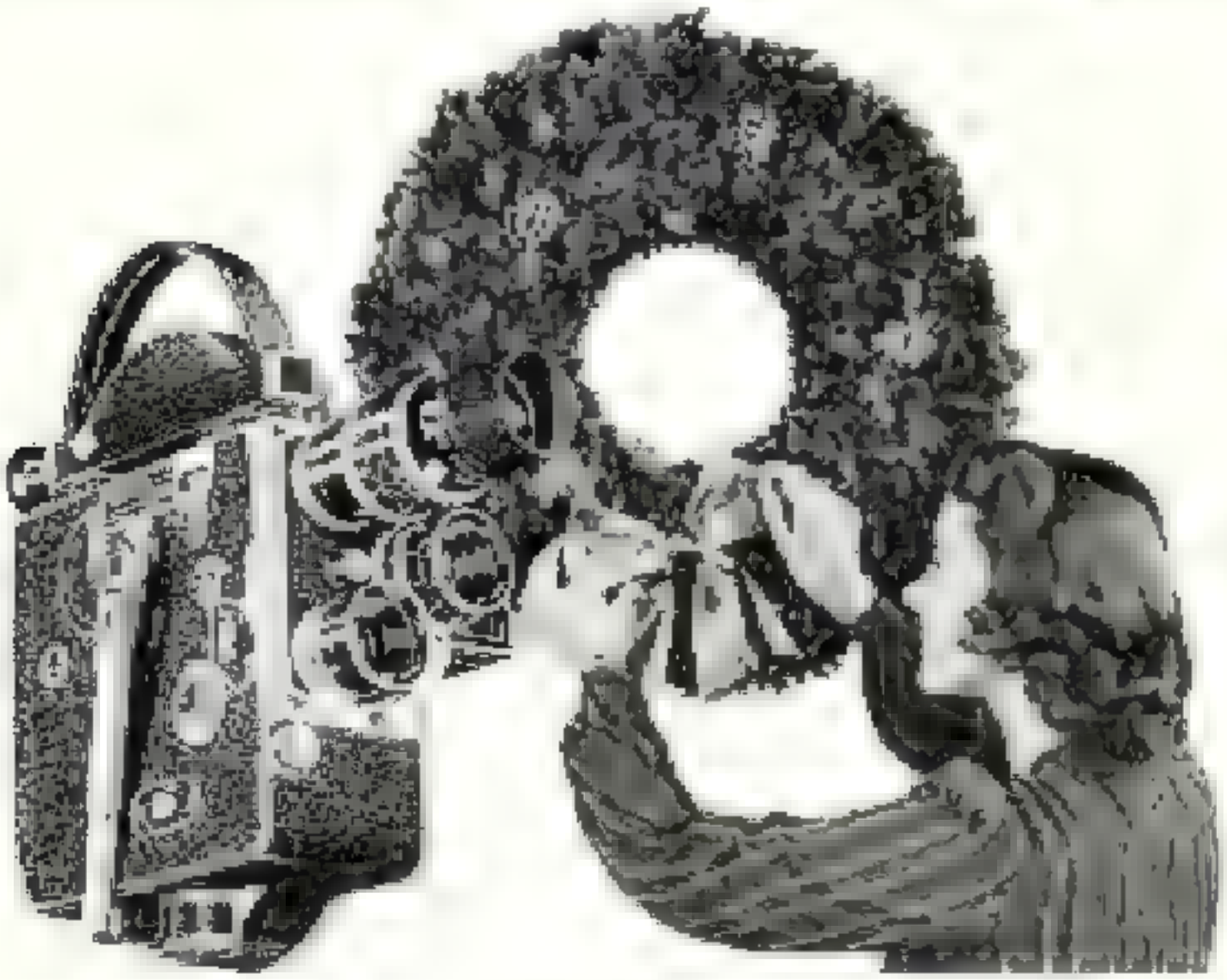

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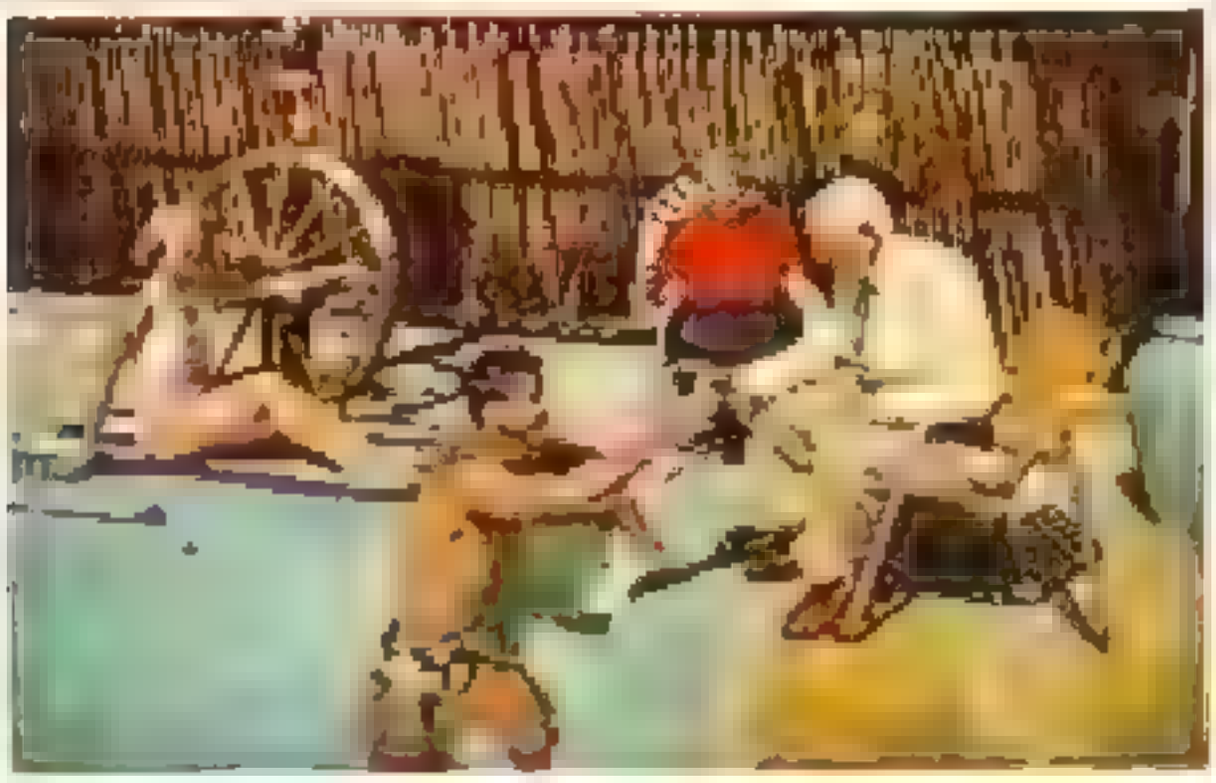

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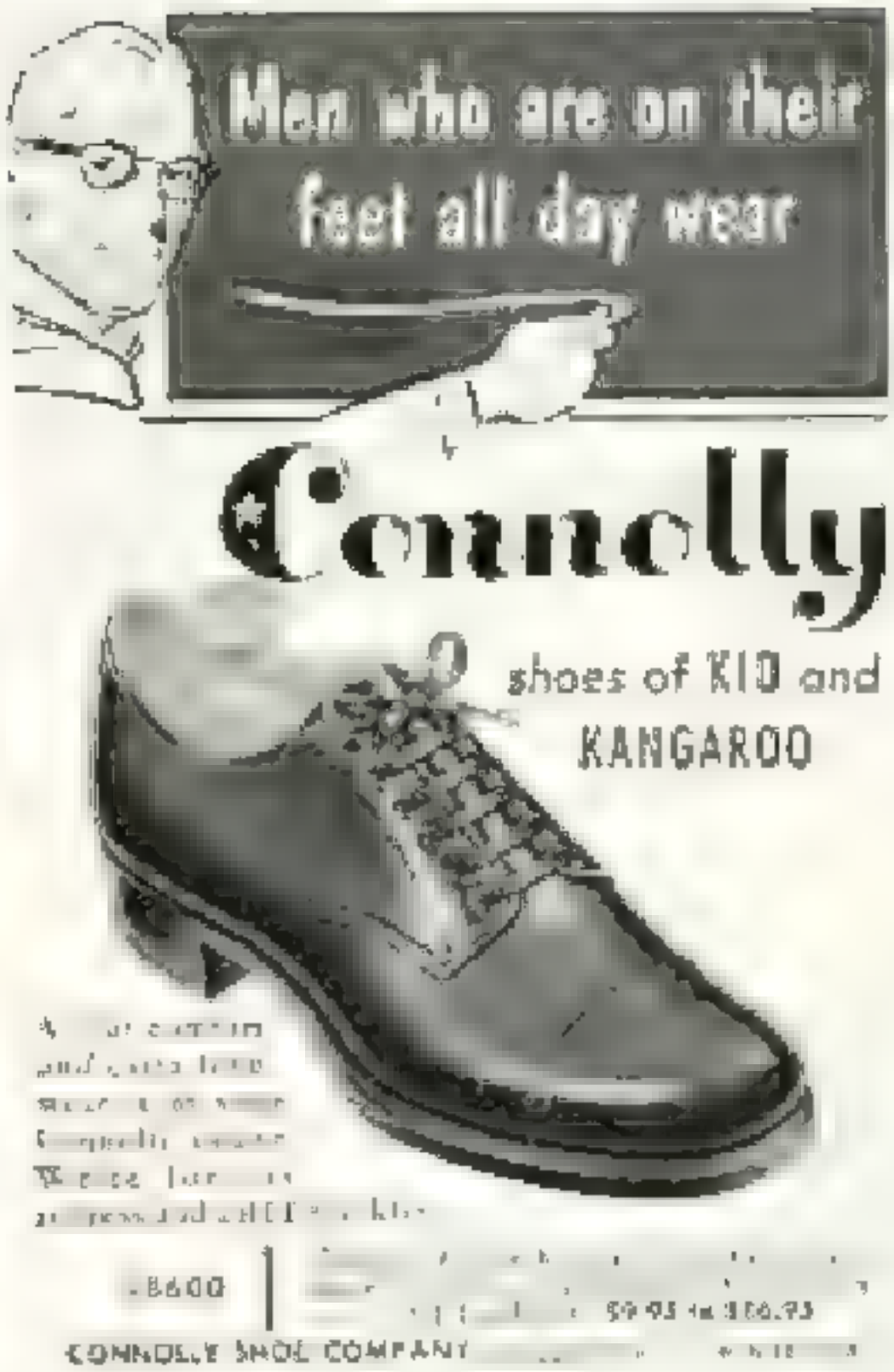

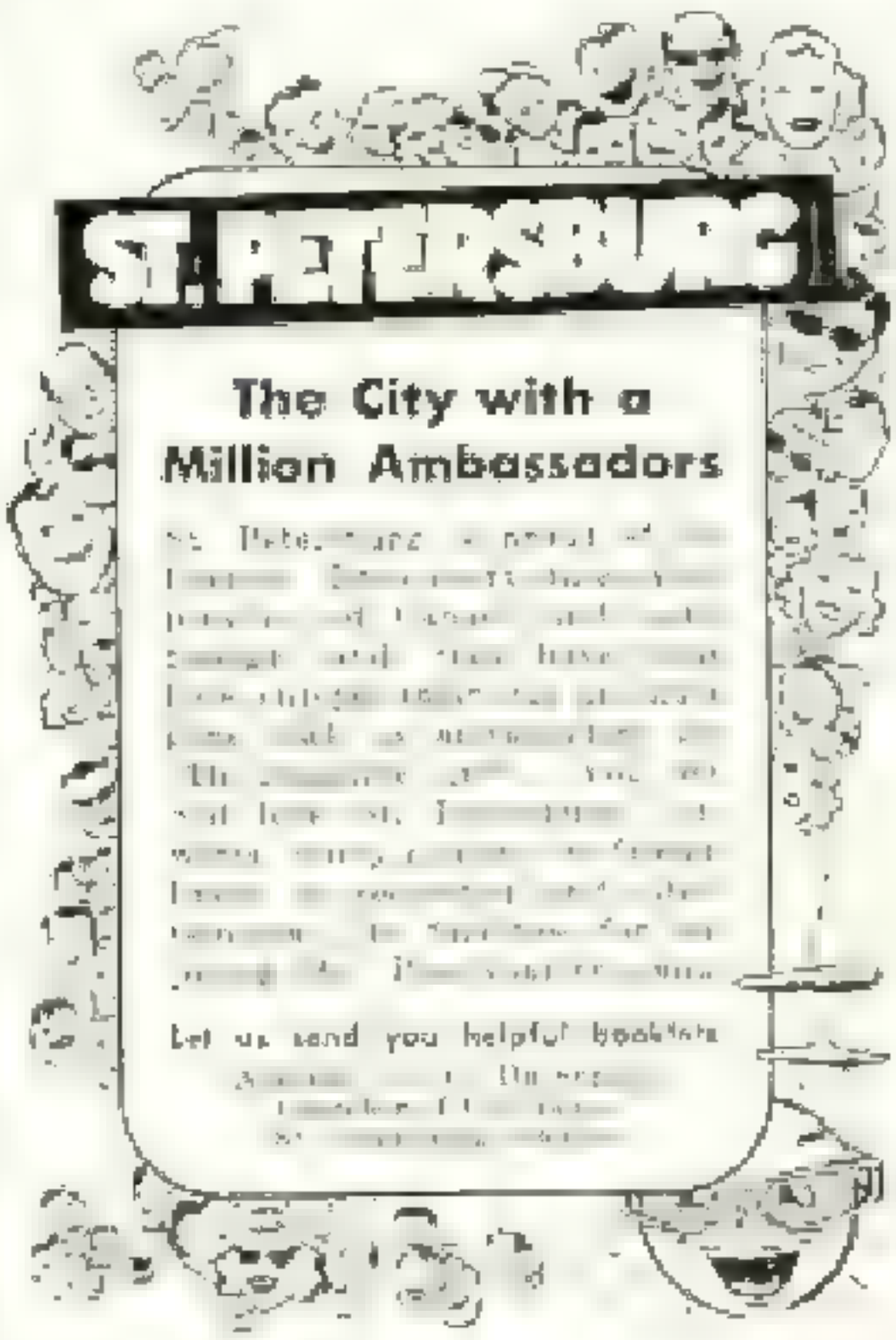

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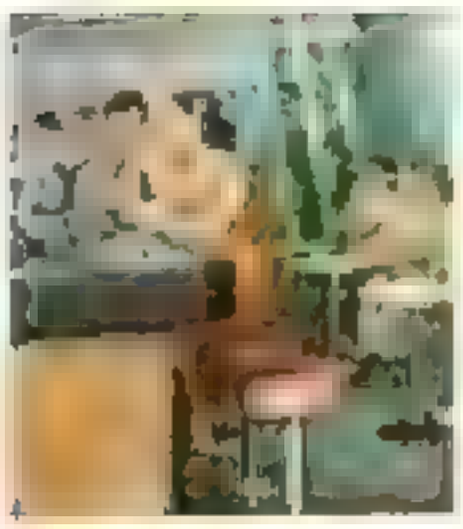

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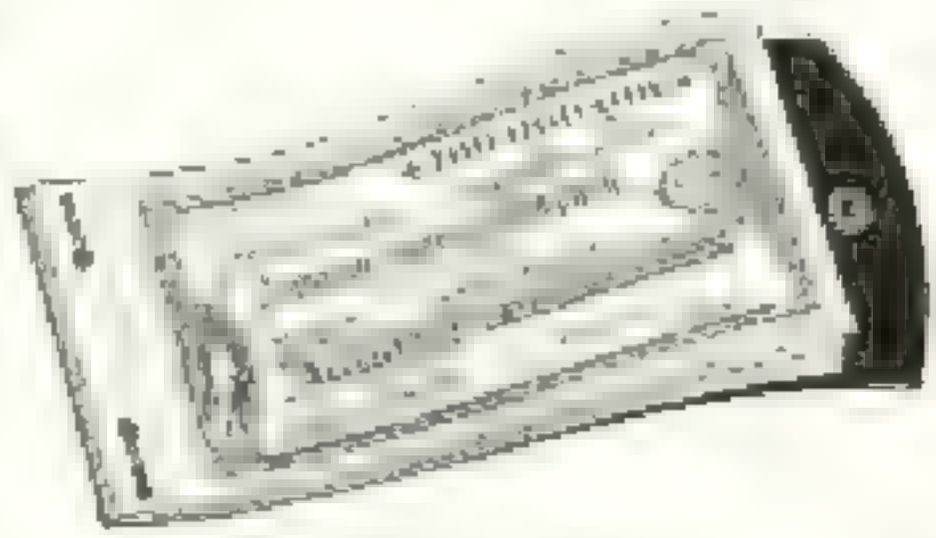

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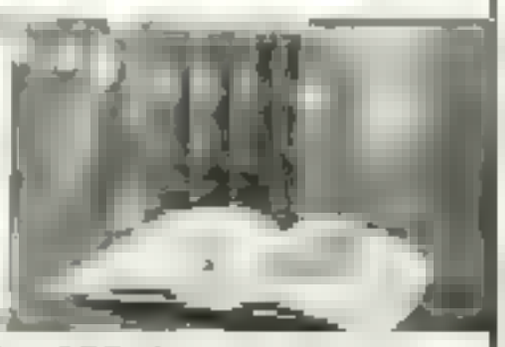

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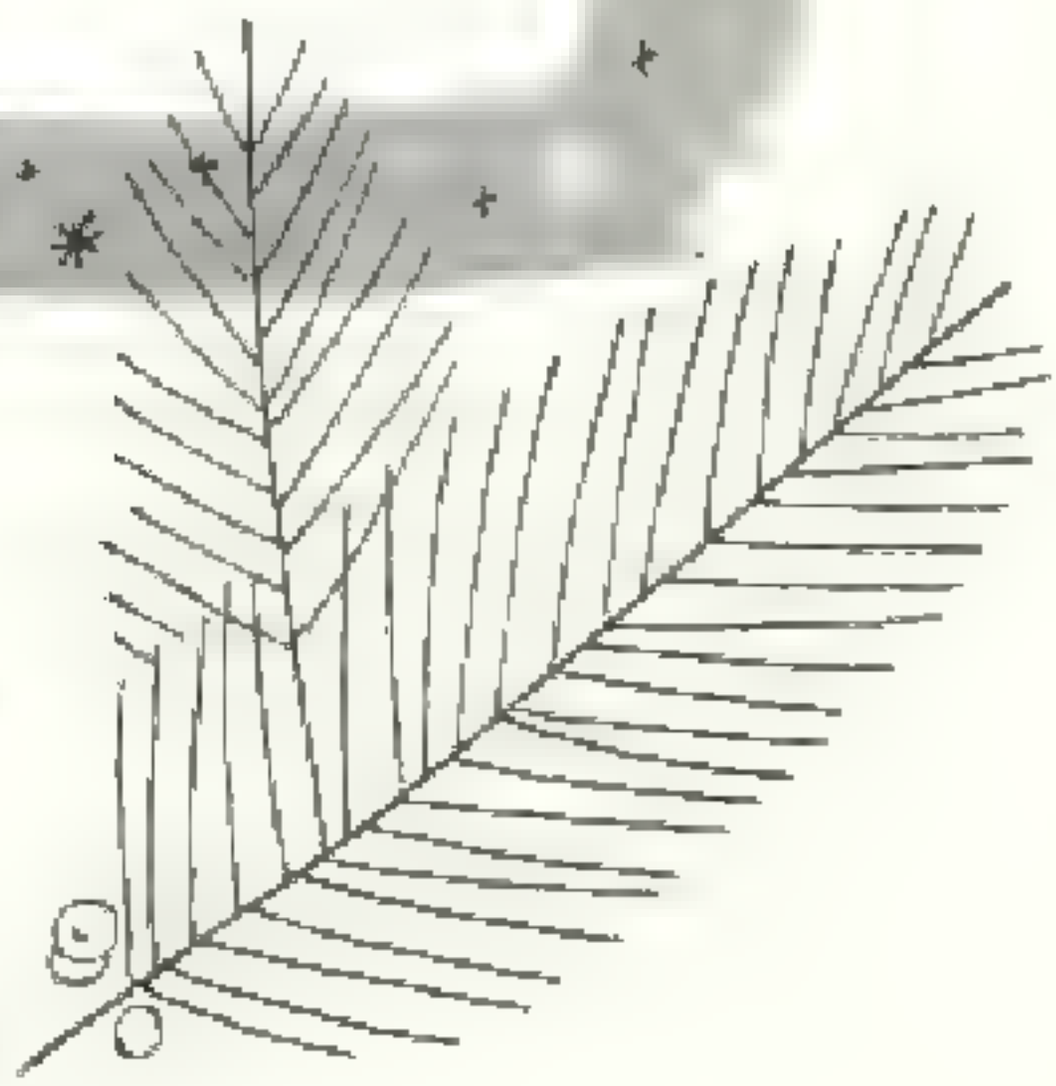

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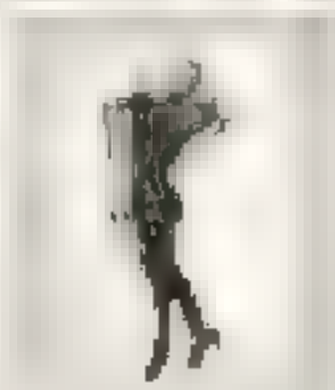

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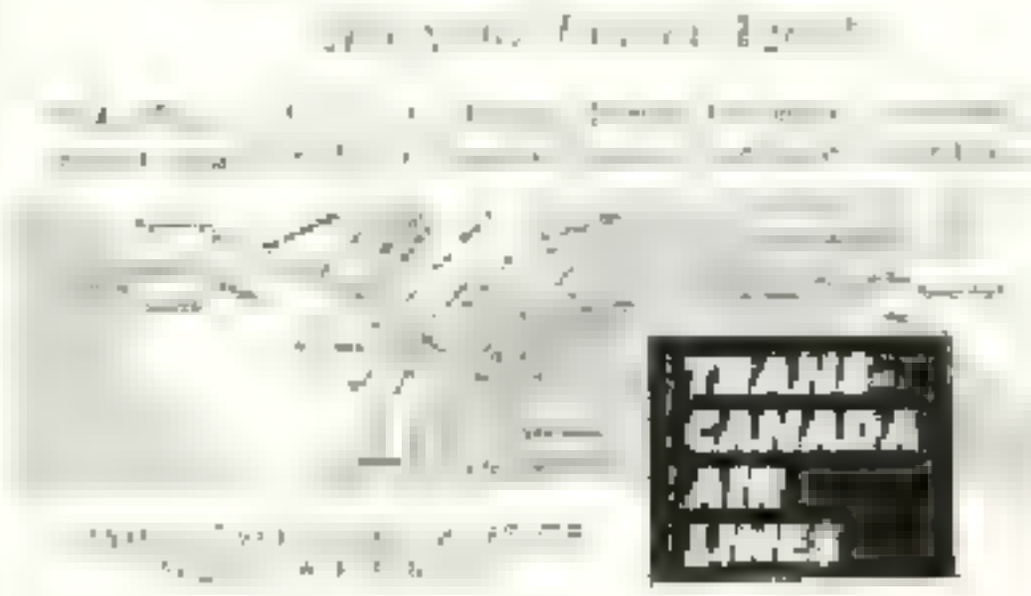

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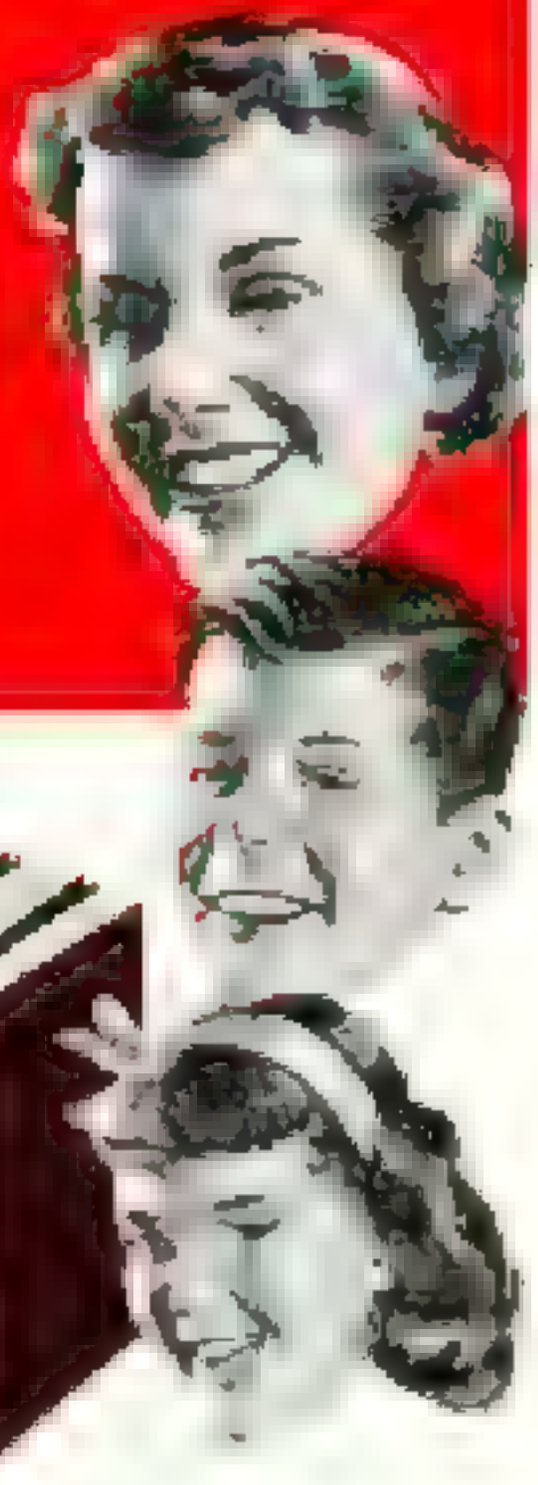

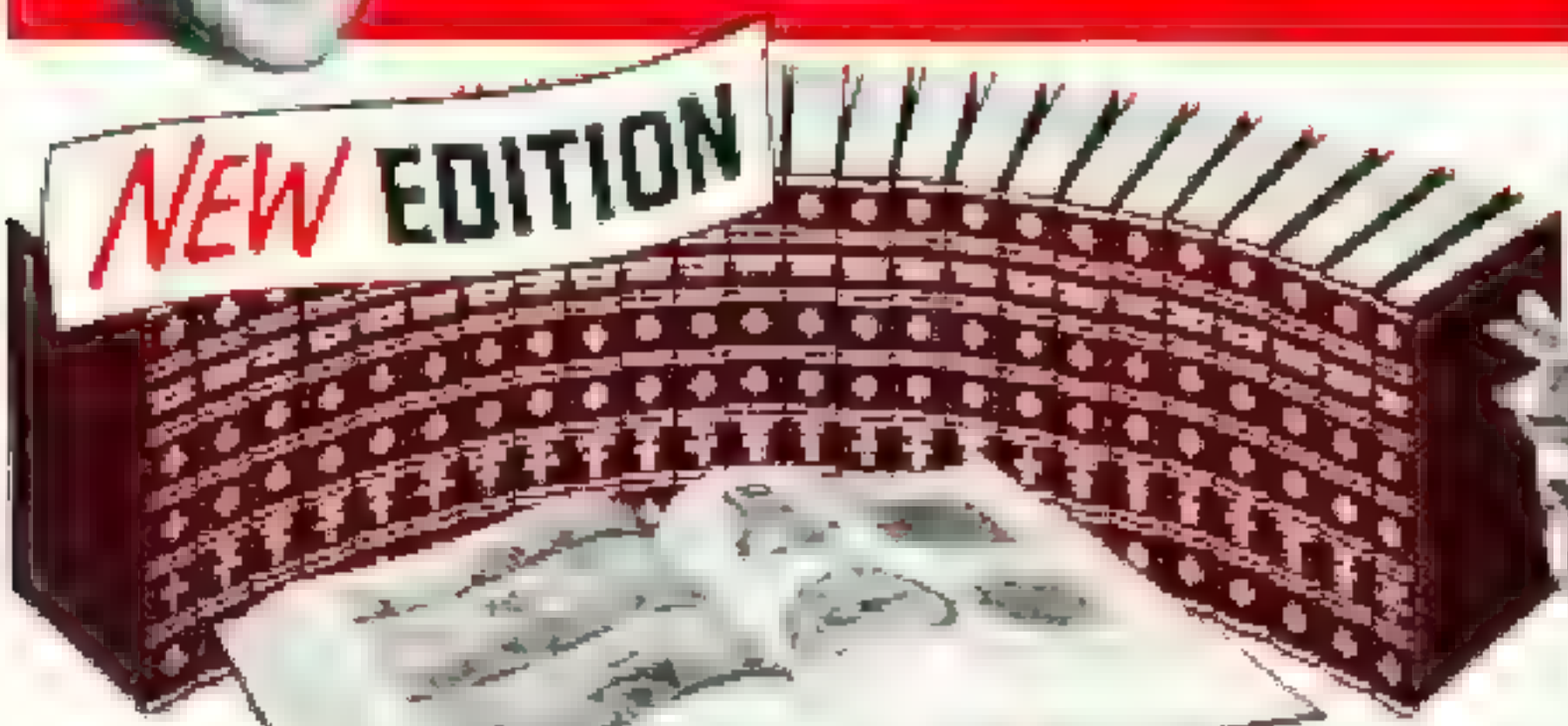

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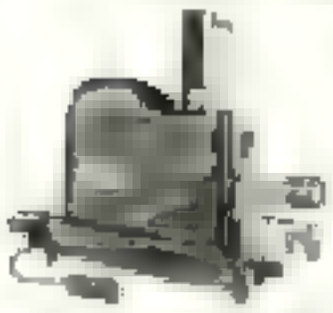

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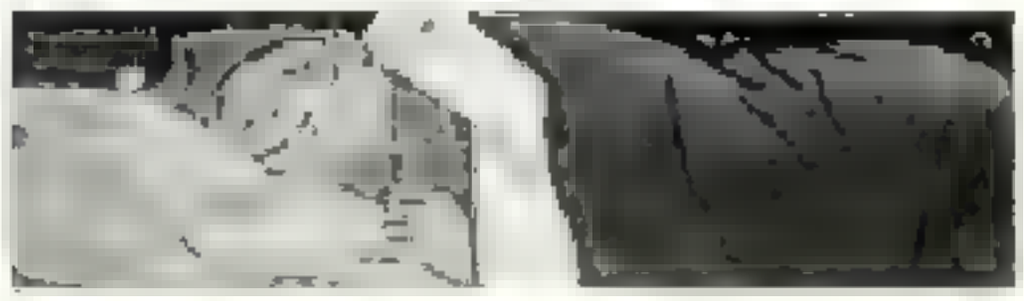

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Nearly everyone knows the famous Aesop fable about the hare and the tortoise. There is a good lesson in it for all of us, but for people who have high blood pressure (hypertension), it has a special meaning.

You may remember that the tortoise "pursued a slow but steady pace straight to the end of the course." Yet he won the race simply by taking it in his stride. Indeed, he took life much, much easier than the hare.

This is exactly what doctors wish that all patients who have high blood pressure, or hypertension, would do. In fact, people who have moderate, uncomplicated high blood pressure are often helped simply by learning to adjust their lives to a slower pace.

A relaxed attitude toward life is important in the treatment of this disease because rush, "drive" and emotional tension can cause an already elevated blood pressure to rise to even higher levels. This is why doctors advise a steady, easy pace during the day and eight or more hours of sleep every night.

In addition, patients should carefully follow their doctor's advice about diet and eating habits. Above all, weight should be constantly kept at the proper level because high blood pressure and overweight [illegible] hand in hand.

People who learn to take these precautions may live happily, usefully and actively with hypertension even to old age.

[illegible] blood pressure [illegible] stays at [illegible] level . . . or if it is caused by an [illegible] sense . . . the situation becomes more serious. Even in these cases, there are often ways to lower pressure and relieve symptoms—such as [illegible] and special diets.

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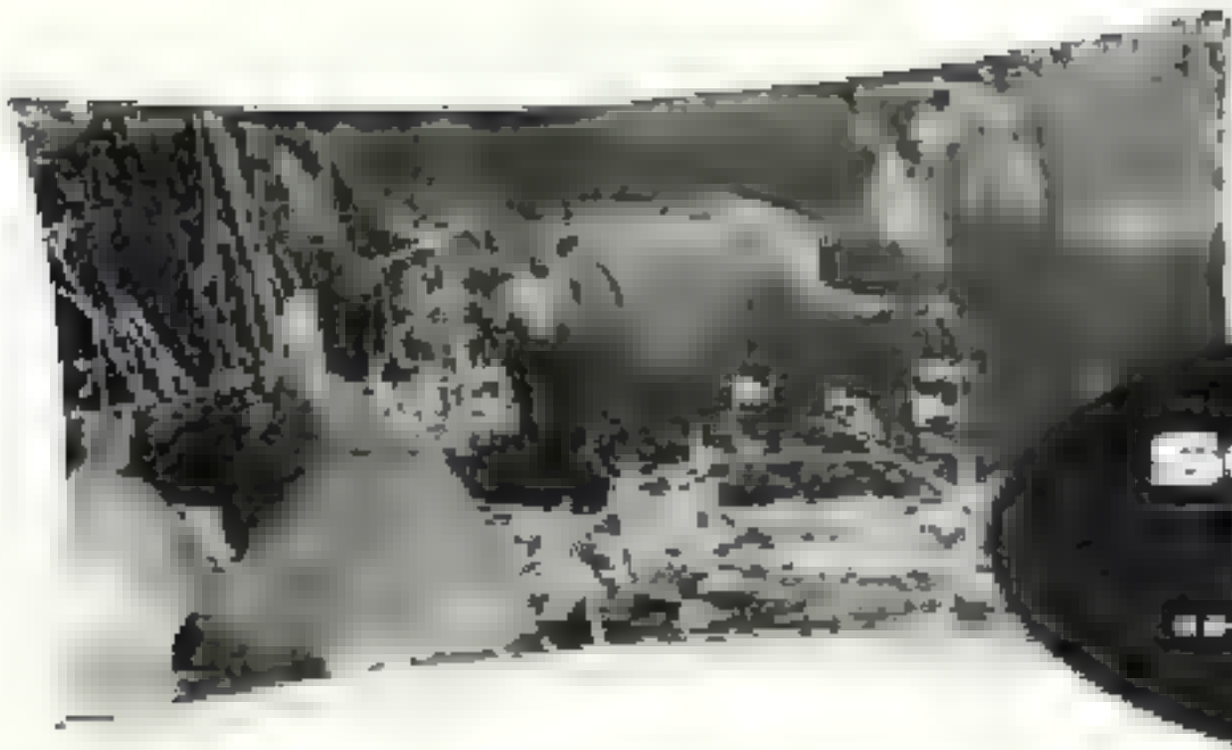

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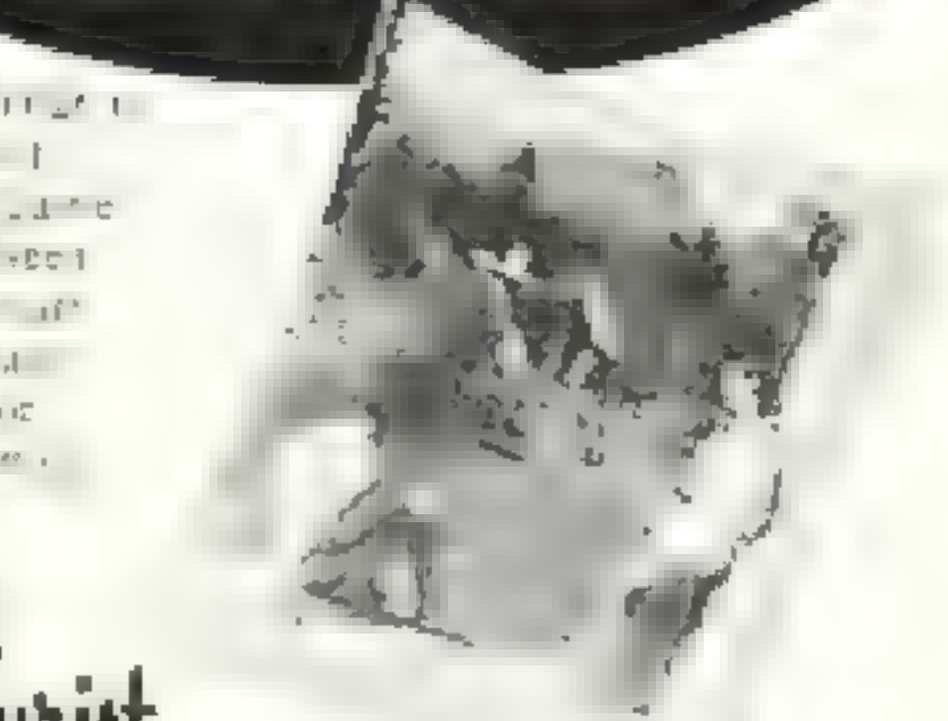

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